Aviation Week
and Space Technology

April 10, 1961

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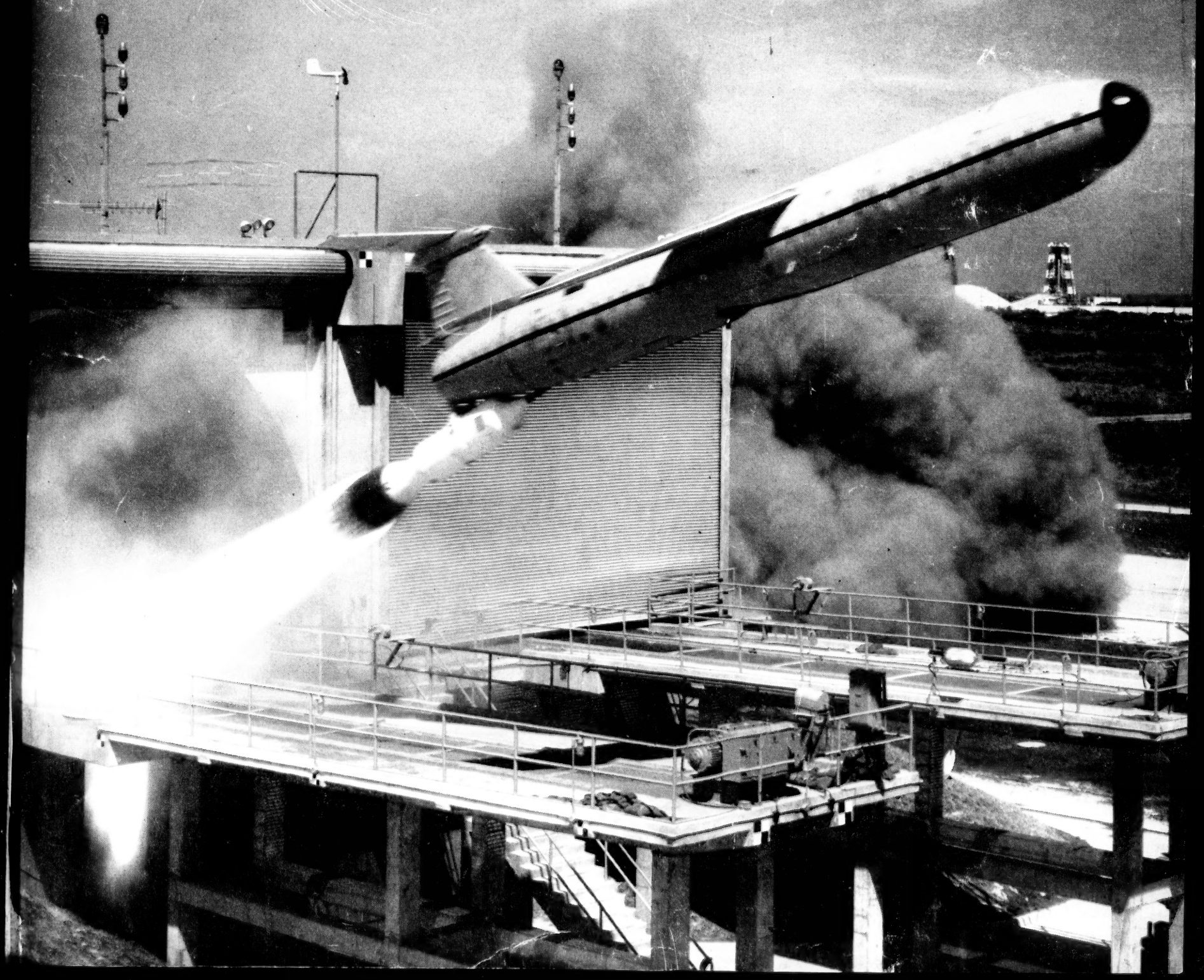

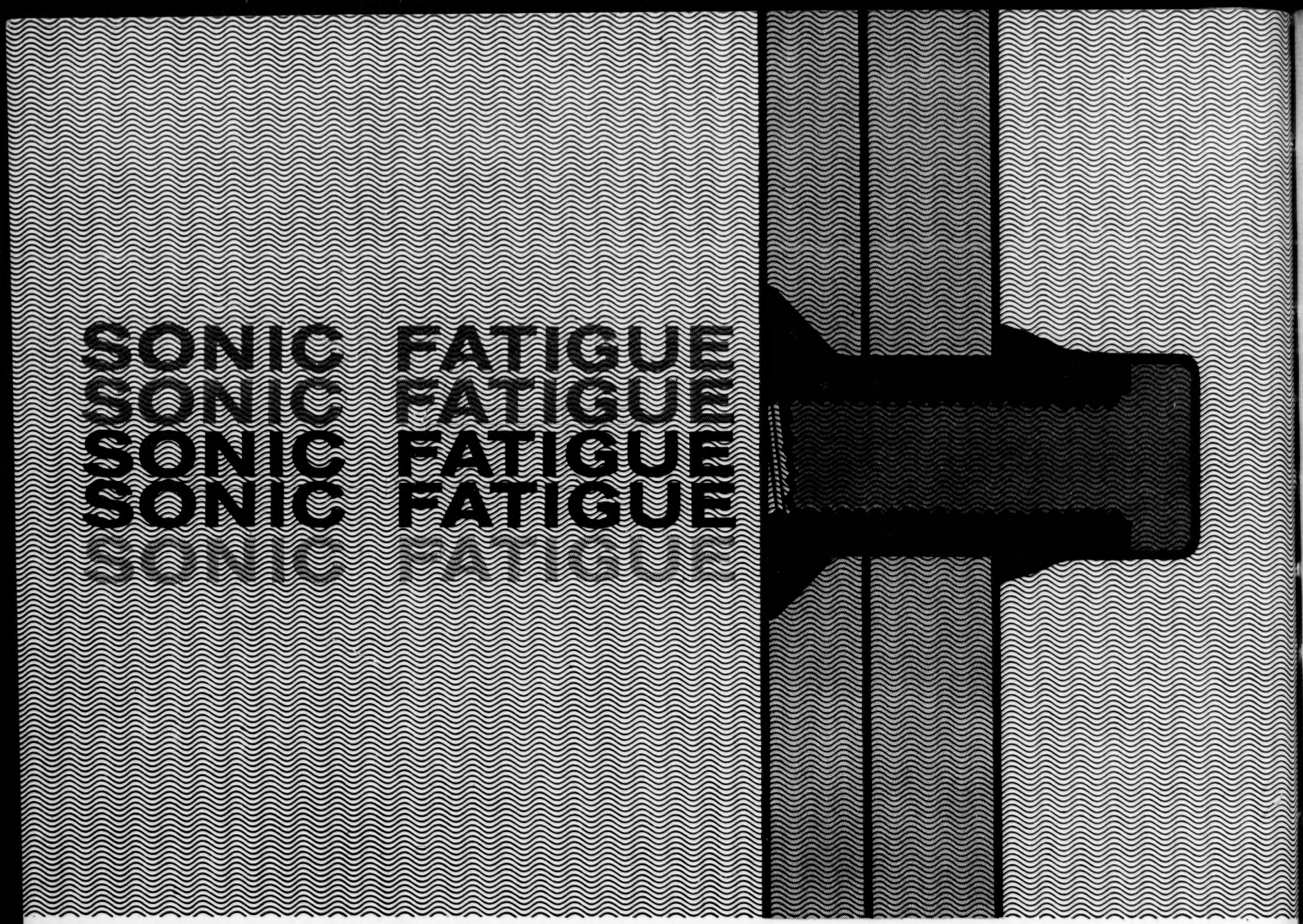

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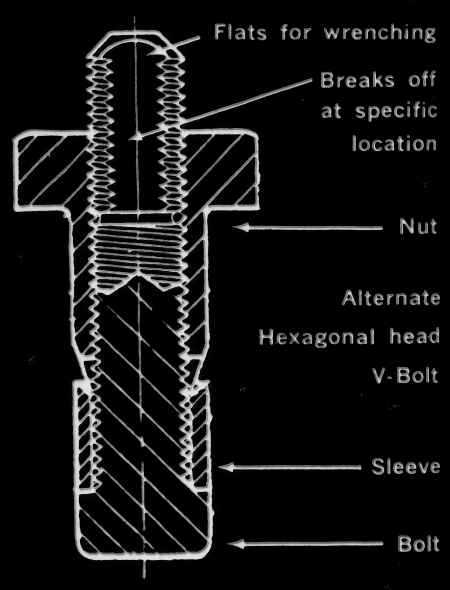

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AVIATION CALENDAR

Apr. 12-13—Symposium on Information and Decision Processes, Purdue University, Lafayette, Ind.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20—Eastern Regional Meeting, Institute of Navigation, Shoreham Hotel, Washington, D. C.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 22-25—Annual Meeting and Conference, American Assn. of Airport Executives, Broadmoor Hotel, Colorado Springs.

Apr. 24-27—32nd Meeting, Aerospace Medical Assn., Palmer House, Chicago.

Apr. 25-27—Ninth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 26—Session on Air Transport Problems, Society of Automotive Engineers' Pacific Northwest Section, New Washington Hotel, Seattle, Wash.

Apr. 26-27—High Temperature Materials Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Pick-Carter Hotel, Cleveland, Ohio.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach, Fla.

Apr. 26-28—Seventh Region Technical Conference, Institute of Radio Engineers, Hotel Westward Ho, Phoenix, Ariz.

Apr. 27-29—13th Annual Air Meet, National

(*Continued on page 6*)

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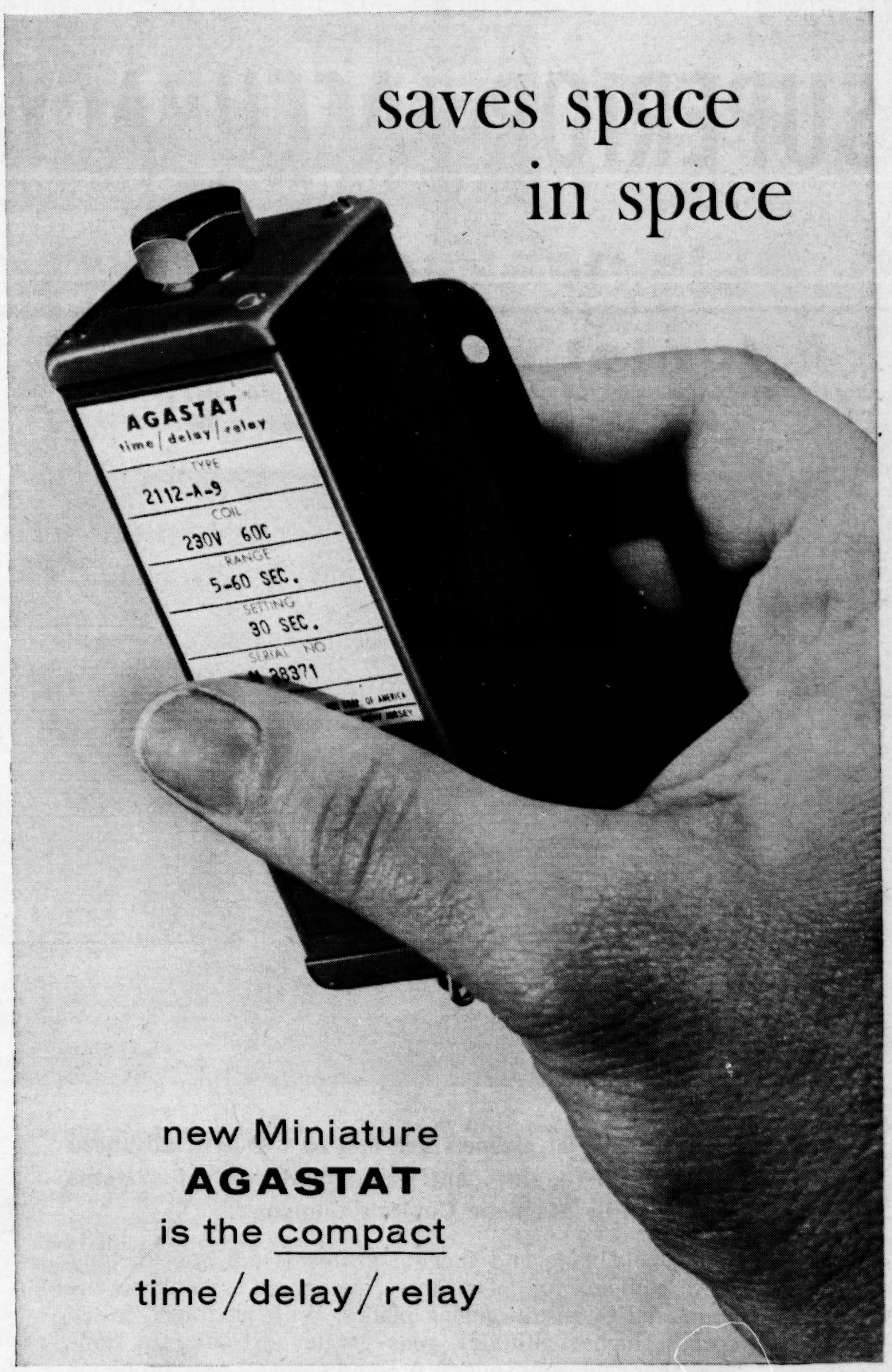

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AVIATION CALENDAR

(*Continued from page 5*)

Intercollegiate Flying Assn., Texas A&M College, College Station, Tex.

Apr. 30-May 4—Seventh National Aerospace Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 2-4—Electronic Components Conference, Institute of Radio Engineers, Jack Tarr Hotel, San Francisco, Calif.

May 3-5—17th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 3-5—Nuclear Applications in Space Conference, American Rocket Society/ Oak Ridge National Laboratory, Gatlinburg, Tenn.

May 4-5—Second National Symposium, Human Factors in Electronics, Institute of Radio Engineers, Marriott-Twin Bridges Motor Hotel, Arlington, Va.

May 8-10—National Aerospace Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 8-12—Annual Meeting, Airport Operators Council, Carillon Hotel, Miami Beach, Fla. (AOC-American Society of Civil Engineers' Joint Seminar, "Increased Capacity of Airport Systems," May 11-12.)

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 11—Air Force Office of Scientific Research Lecture and Banquet in honor of the 80th Anniversary of Theodore von Karman, Sheraton Park Hotel, Washington, D. C.

May 12—National Armed Forces Day Dinner, Sheraton Park Hotel, Washington, D. C.

May 15-16—Region One Air Traffic Control Assn. Convention, Hotel Bradford, Boston, Mass.

May 15-16—Aviation Fire Safety Seminar and Technical Session, National Fire Protection Assn., Hilton Statler Hotel, Detroit, Mich.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

May 31-June 2—University of Michigan's Seventh Annual Radar Symposium, Ann Arbor, Mich.

June 2-3—12th National Maintenance and Operations Meeting, Reading Aviation Service, Inc., Reading, Pa.

June 13-15—National Joint Meeting, Institute of the Aerospace Sciences and American Rocket Society, Ambassador Hotel, Los Angeles, Calif.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

April 10, 1961

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COVER: USAF-Martin Mace TM-76B is launched from Air Force Missile Test Center, Patrick AFB, Fla., on an 800-mi. simulated tactical mission that required its AC Spark Plug inertial guidance to change course four times and change altitude seven times. Mace, powered by a 5,200-lb. thrust Allison J33-A-41 turbojet engine and launched with the aid of a solid propellant booster, will be deployed in hardened underground sites similar to these twin launching bays.

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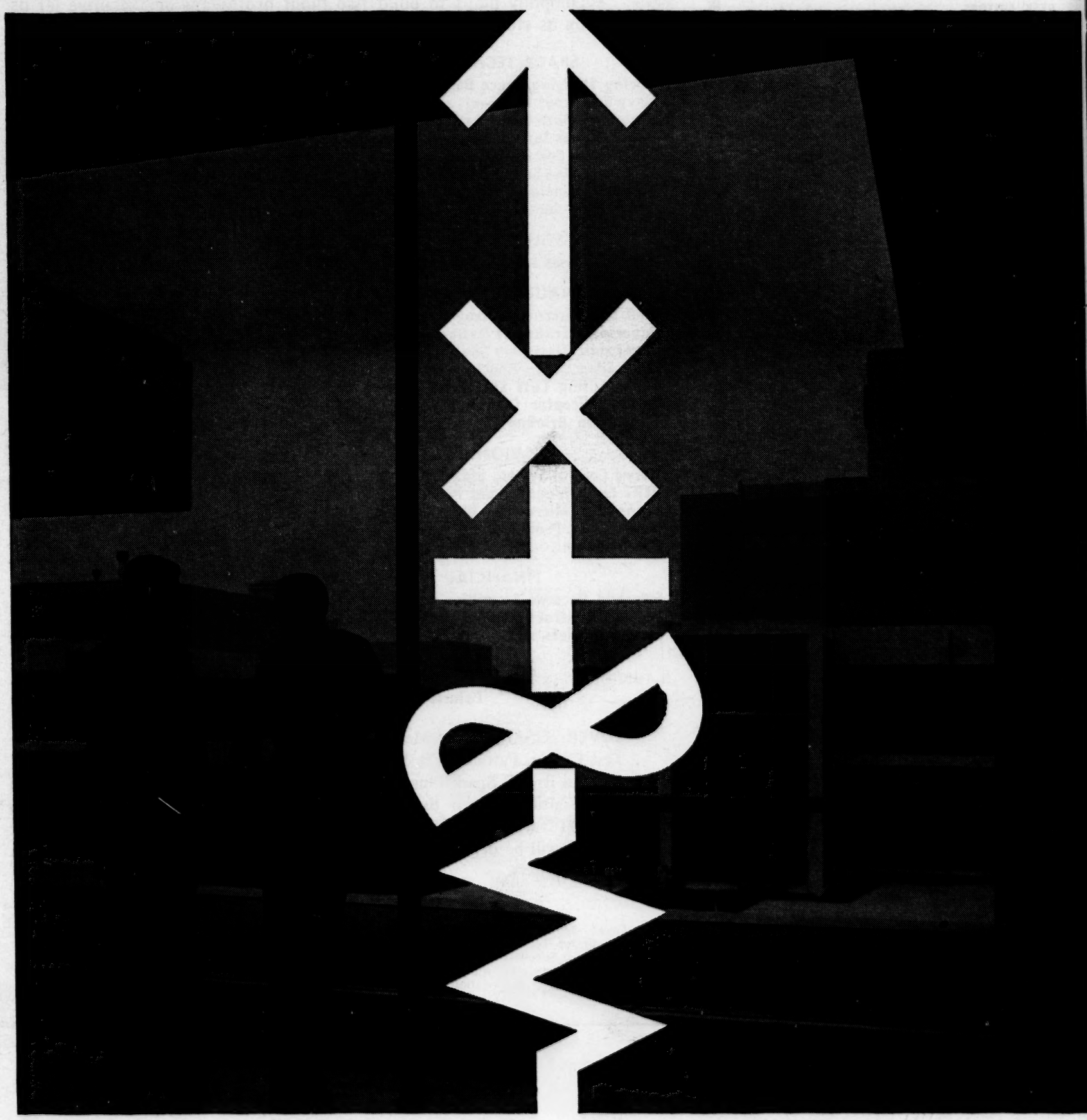

EDITORIAL

Polaris on Station

During the past five months, a radically new element has been added to the U.S. strategic deterrent posture by the Polaris solid-fueled ballistic missiles emplaced under the sea in nuclear-powered submarines. The Polaris-firing submarines George Washington and Patrick Henry have already made successful combat cruises carrying their multi-megaton loads in the ocean depths for more than two months at a time. The Robert E. Lee has completed its firing trials and is due for its first combat patrol soon, while the Theodore Roosevelt is in the midst of its firing tests on the Atlantic Missile Range. It will be followed in combat status by the Abraham Lincoln and Ethan Allen. By mid-summer, there will be six of these submarines combat-ready, carrying a total of 96 Polaris missiles on station as a significant increase in both the quantity and survivability of our deterrent forces.

The submarine-emplaced Polaris is not an invulnerable weapon system nor is it the sole answer to the problem of deterrence in the missile era. But it does add a unique element of complexity to any potential enemy's aggressive intentions, and it makes its contribution within a time-scale of enormous significance in the current and near future international balance of military power. Along with the hardened land-based ICBMs and the airborne Hound Dog and Skybolt missiles, the Polaris submarines should form a deterrent pattern of sufficient firepower, dispersion and survivability from surprise attack to provide a stable deterrent force in the missile era.

In an era when traditional types of military organizations have become less and less able to cope with the problems forced on them by the galloping technologies of our times, the Polaris program provides one of the best examples of a military-technical-management pattern that effectively harnessed the new technologies to a military problem within a short enough time period to be significant in the international power scale.

Although the Polaris program now embraces nearly 9,000 organizations down through its third tier of subcontractors and has utilized the resources of universities, research institutes and other government agencies, it began with a single Navy admiral, "Red" Raborn, his single assistant and a piece of paper signed by the chief of naval operations that said simply: "Give this officer whatever he needs."

The period from the creation of Navy's Special Projects Office in December, 1955, to study the problem of developing ballistic missiles for use at sea to the date the George Washington put to sea for its first combat-ready patrol Nov. 15, 1960 was less than half the normal military development cycle time for a new weapon system. From the time the Polaris was officially approved as a project in its present form on June 1, 1957, to the time this summer when an effective, combat-ready Polaris submarine force will be deployed will be only four years—a truly remarkable record.

The Polaris program has pushed many basic state-of-the-art advances along a wide spectrum of technology. With Atlantic Research Corporation's breakthrough on specific impulse, it sparked a resurgence of interest in solid propellants and mastered the techniques of controlling large solid-fueled rocket motors in addition to developing new high temperature metals to permit better performance. Sparked by Dr. Stark Draper's Massachusetts Institute of Technology inertial guidance group, the Polaris guidance system pioneered the reduction of this equipment into extremely small packages of high precision performance. Submarine navigation was developed to 10 times its earlier precision, and basic new techniques of high speed warhead re-entry that evolved from Polaris development have been applied to other types of ICBMs.

These technical advances are still continuing and, as an extremely interesting facet of the Polaris management techniques, have been carefully scaled in time to produce a constantly improving missile from the original 1,200-mi. range A1 now in use to the 1,500-mi. A2 and and the 2,300-mi. A3 model whose development will be accelerated under the new defense budget.

From the taxpayer's viewpoint, this provides major insurance against too rapid obsolescence of the multi-billion dollar investment in the Polaris weapon system. From the military viewpoint, it provides the Polaris system with increased survivability by permitting the submarines to operate and fire farther out in the oceans where their detection, pursuit and attack becomes even more difficult for an enemy that has no land bases along the Atlantic rim.

Polaris also produced significant state-of-the-art advances in the techniques of military-technical management. This management pattern organized by Adm. Raborn and his crew, with Lockheed Missiles & Space Division as prime missile system manager, should be carefully studied as a prime example of how to approach the increasingly complex problems of welding scientific, industrial and economic resources into the desired end product fast enough to be significant either in military or industrial competition. The PERT electronic management device developed in the Polaris program has been the foundation for a variety of similar systems now being widely used in industry.

Among the other outstanding management achievements in Polaris are the standardization of highly complex components, such as gyros, produced by as many as four separate sources; the fixing of responsibility with authority all down the management chain; and the streamlined overhead that used only 700 persons, including clerical help, to manage what ran as better than a billion-dollar-a-year program.

The Polaris program is a heartening example of what this country's technology, industry and military leadership can accomplish when they organize properly and proceed with firm decisions toward a well-defined goal no matter how far out on the technical horizon it may loom at the outset.

—Robert Hotz

RECONNAISSANCE, THE LACK OF IT, AND A FAULTY COMMAND DECISION

The year is 1862. The Army of the Potomac, 70,000 men in blue, is primed to do battle. Facing them, General John B. Magruder's divisions of the Confederate Army of Northern Virginia firmly entrenched before Richmond, but numbering only 15,000. The sheer weight of Federal men and equipment apparently is sufficient to gain the victory, destroy the Southern force, capture the Confederate capital and perhaps end the war.

But General George B. McClellan, the Union Commander, never orders the advance. Why?

During the years preceding the war, adequate provisions for reconnaissance had not been made. McClellan's intelligence, directed by the famous detective Allan Pinkerton, overestimated the strength of the Confederate forces . . . *overestimated those forces to be twice those of the Army of the Potomac.* During this early phase of the War, Union reconnaissance cavalry is too inexperienced and limited in number to verify this civilian intelligence. And so this singular Union opportunity slowly ebbs—dissolving into three more years of bloody warfare . . . the result of a faulty command decision.

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Edwin J. Jackson, manager-aircraft instrument engineering, General Electric Co.'s Instrument Department, West Lynn, Mass.

Benjamin H. Cook, public relations manager, California Division of Lockheed Aircraft Corp., Burbank, Calif.

E. L. Bunnell, military sales manager, Field Aviation Company, Ltd., Toronto.

(*Continued on page 118*)

INDUSTRY OBSERVER

► Team of Hughes Aircraft and Chance Vought is offering to build a communications satellite and launch it into a synchronous equatorial orbit with a Scout booster for $20 million under a fixed-price contract as evidence of their confidence that they can do the job. Price would include cost of launching from Jarvis Island, a U.S. Pacific island near the equator. Plan has been proposed to Defense Department and several communications common carriers. Price is based on providing five vehicles and satellites to assure successful orbit.

► **Proposal request for shipboard long-range input (SLRI), which would supplement Air Force's airborne long-range input (ALRI), may be issued late this year. ALRI is an airborne radar-data processing seaward extension of the SAGE system, and SLRI would add capability for supplementary surface warning of airborne attacks. Airborne tests of ALRI are now being flown from Ontario, Calif., and are scheduled to be completed in mid-summer.**

► Second Short SC.1 VTOL research aircraft, retained by the company at Belfast for development, is being modified for all-weather flight with a semi-automatic landing system. Biggest problem is to control deceleration before landing. More than 150 SC.1 complete transitions have been made in free flight, and the first "jump" takeoff has been made from a solid runway—in spite of its unfavorable ground effect compared with a slotted platform.

► **USAF's Project Asset (aerothermodynamic structural systems evaluation test) calls for launching of six or seven hypersonic glider models on Blue Scout boosters to study the effects of heating on structures of the type that will be used on Dyna-Soar and follow-on boost-glide vehicles. Gliders will be fired to velocities of 19,000-20,000 fps. and altitudes reaching 400,000 mi.**

► Initial acceleration of Army's Western Electric-Douglas Nike Zeus anti-ICBM missile is nearly 630 fps. To get this extremely high performance, development of the 47-ft., 22,000-lb. missile is reported to have accounted for about a third of total system development costs. In production, all airborne elements of the system are expected to amount to 12% of the total cost of a minimum-strength Zeus installation.

► **Wright Air Development Division will support a new study of how various materials withstand high intensity electromagnetic radiation under various environments. Contract award is expected shortly.**

► Fairchild VZ-5 deflected slipstream VTOL test vehicle is still undergoing wind tunnel testing at NASA's Langley Research Center. It is expected shortly to join the other three Army VTOL testbeds, which have been in flight status for several months.

► **Army has canceled plans to launch a series of Sperry Sergeant missiles from San Nicholas Island into the Pacific Missile Range's sea test range. The firings had been intended to determine how test data collected in the high desert climate of White Sands Missile Range is altered in humid, sea level operations.**

► Several Cape Canaveral launching pads which handle Atlas-boosted space vehicles may be given dual vehicle capability under various schemes USAF and NASA are studying. One plan calls for Pad 12, which already has been used for Atlas-Agena in the Midas program, to handle both Atlas-Agenas and Atlas-boosted Mercury vehicles; for Pad 13 to handle both Atlas-Agenas and Atlas-Centaurs; for Pad 14 to handle Mercury only; and for Pad 36B—now scheduled only for Centaur—to handle both that and Atlas-Agenas.

► **Navy has been investigating possible use of an optical maser capable of generating coherent beams of yellow-green light as a means of detecting submerged submarines. Higher frequency electromagnetic energy, including light waves, generally are attenuated severely under water, but a window in the yellow-green portion of the visible light spectrum may permit light of this color to travel over relatively long distances under water.**

SILICOLOGY

Studies in Silicones

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Immersion Fluid	% Volume Change	
	7 days 70°C.	4 days 100°C.
10* L-45	−0.51	−0.15
100* L-45	−0.47	−0.55
1000* L-45	−0.58	−0.69
1000* L-45 + 2.5% "Plexol" 201	4.47	3.75
1000* L-45 + 7.5% "Plexol" 201	17.02	18.60
L-527	8.34	10.66
Water	9.73	15.75

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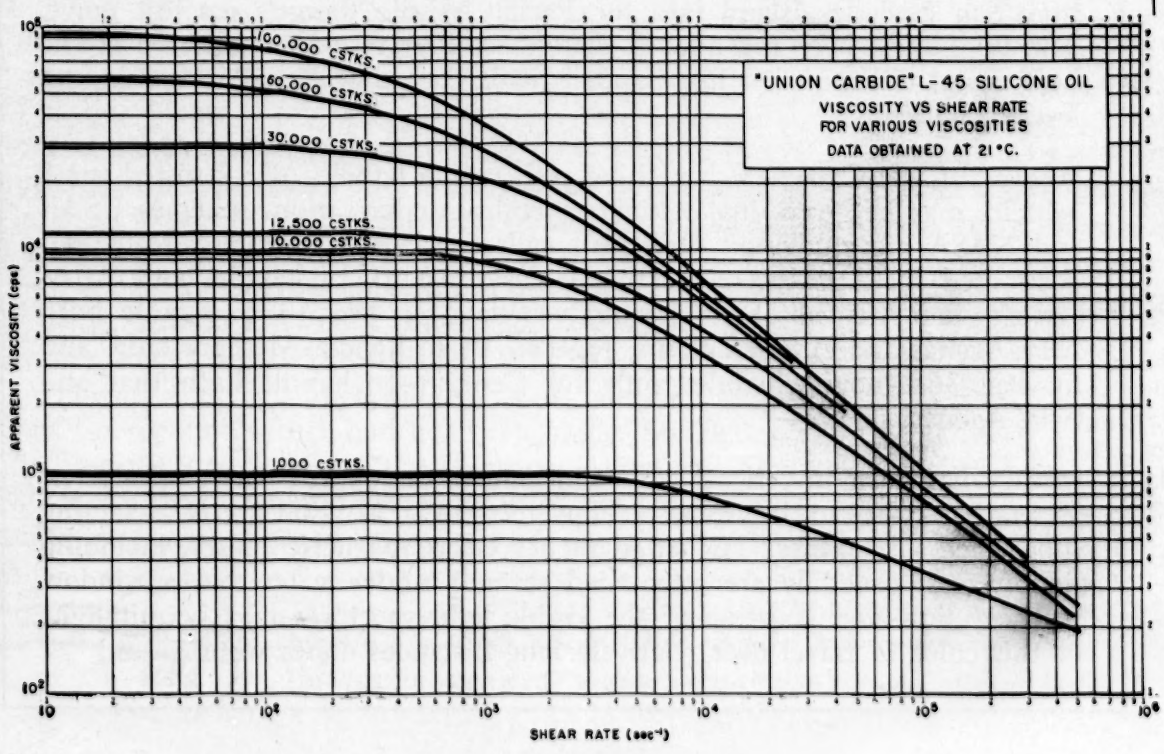

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Washington Roundup

Disarmament Studies

John J. McCloy, the President's disarmament adviser, and Walter Heller, chief of the President's Council of Economic Advisers, have held preliminary talks on the possibilities of coordinating studies of the international and domestic aspects of various disarmament plans.

Betty Goetz, named last week by the President as special assistant to McCloy, will continue to direct the comprehensive study of the Senate Foreign Relations Subcommittee on Disarmament (AW Feb. 13, p. 26) on the impact of the cancellation of defense business on major defense contractors, as well as on business generally. She was formerly staff director for the subcommittee. The study is nearing completion.

Meanwhile, draft proposals of legislation to establish a disarmament organization—either in State Department or as an independent agency—are being circulated among top executive branch officials for comment.

Atomic Energy Commission does not plan to orient its reactor and materials research program toward any aircraft nuclear propulsion (ANP) applications. Instead it will absorb its former ANP funds into its broad research program on reactors and materials.

The agency also wants to move this research from the General Electric and Pratt & Whitney ANP facilities and into its own laboratory at Livermore, Calif. It claims the contractors' facilities are too expensive for the amount of work that would remain there.

Air Force is recommending that President Kennedy's proposed acceleration of the phaseout of B-47 strategic bomber wings be postponed for a year. In the past year, B-47 wings already have been reduced from 20 to 13, cutting out a total of 315 aircraft.

Joint Fighter Project

Defense Secretary Robert McNamara is insisting that the TFX tactical fighter, which originally was an Air Force proposal, be developed as a tri-service project. He saw what he considered duplication in the STOL fighter area and ordered a consolidation. Defense's research and engineering office looked over the requirements of the three services and found them incompatible. But McNamara now has sent a team from that office out to ask manufacturers if the various requirements can be incorporated into one aircraft.

At the same time, Air Force is under pressure to consider using the Navy McDonnell F4H. Its two General Electric J79 engines give it some 36,000 lb. of thrust, and Marine Corps is operating it out of 3,000 ft. strips.

Reorganization at the Air Staff level to conform with the new Air Force Systems Command and Air Force Logistics Command structure will turn the former deputy chief of staff-materiel office into deputy chief of staff-systems and logistics. It will be headed by Lt. Gen. Mark E. Bradley, Jr., who now holds the materiel post. He will have two deputies—one for systems, one for logistics. Maj. Gen. Marvin C. Demler, now director of aerospace systems development under the deputy chief of staff-development, is slated for the systems job, and Maj. Gen. W. O. Senter, now assistant deputy chief of staff for materiel, is to get the logistics job.

The present deputy chief of staff-development office will become deputy chief of staff-research and technology, with the new Office of Aerospace Research reporting to it. Lt. Gen. Roscoe C. Wilson, now deputy for development, would head the research and technology office.

Space Council Change

Legislation to change the national space act so Vice President Lyndon Johnson can head the National Aeronautics and Space Council is expected to go to Capitol Hill this week. The present intention is to make the council a national space program planning body rather than just a body for settling disputes.

While President Kennedy will seek advice from the council, he will not abandon his present practice of soliciting space advice from individuals—chiefly Johnson, presidential science adviser Jerome B. Wiesner and the administrator and deputy administrator of National Aeronautics and Space Administration.

Watch for presidential science adviser Jerome B. Wiesner to create a panel on super-boosters to determine which of those now in development should continue, whether new ones are needed and whether Air Force or National Aeronautics and Space Administration should develop any new ones that are ordered.

Air Force will reduce the number of Study Requirements (SRs) and limit their forward look to about 10 years in most instances, following criticism that these study efforts are tying up many of the nation's best scientific minds. In the future, Under Secretary Joseph Charyk must approve initiation of all SRs.

—Washington Staff

Boeing Studying Space Bomber Concepts

Three-year Air Force Boss-Wedge program includes assessment of manned, unmanned military systems.

Extensive series of studies to assess the value of using manned and unmanned space vehicles in bombing, reconnaissance and other military missions is being conducted by Boeing Airplane Co. for the Air Force Systems Command under a broad three-year program known as Boss-Wedge.

The term Boss-Wedge is a combination of the acronyms Boss, from bomb orbital strategic system, and Wedge, from weapon development glide entry, which are the designations for the principal parts of the over-all space bomber concepts.

Selection of Boeing to run the studies, in which several other leading aerospace firms are participating, indicates that Dyna-Soar boost glide vehicle concepts figure prominently in the investigation. The company has been funded principally under the Boss-Wedge program by the former Wright Air Development Division of Air Research and Development Command for advanced research and development on follow-on versions of Dyna-Soar. These additional vehicles are designated Dyna-Soar II, Dyna-Soar III and Dyna-Mows, for manned orbital weapon system, an advanced version of Dyna-Soar III.

One of Boeing's primary aims in Boss-Wedge, according to industry sources, is to assure itself a pre-eminent position in future military space weapon programs by exploring all ways and means of using space weapons in the Boss-Wedge program. Then, should the Department of Defense issue a go-ahead on any specific military vehicle or system approach, it will be in a commanding position to follow up on the project. As a consequence, a multitude of weapon ideas are being pursued. Both manned and unmanned weapon schemes, utilizing Dyna-Soar, Slomar (AW Oct. 24, p. 23) and other vehicle concepts are under consideration.

Any of these studies may mature beyond study into the hardware feasibility stage, industry sources say.

Two Teams Assist Boeing

To conduct the studies, Boeing has assembled two teams, each composed of a number of aerospace companies with combinations of talents that Boeing does not itself possess. Working with it in Boss-Wedge are several of the companies participating in the current Dyna-Soar program.

Boeing directs each team, but each functions independently, following similar work statements. Because each team is competing for the best technical approach and to avoid compromising the independence of either group, companies on one team are cautioned against discussing the project with any company on the other team. Members of each team meet at periodic workshops conducted by Boeing.

Boeing is responsible for project management, aerodynamics, boosters, logistics and support for both teams. Members of the first team and their functions are:

- **Guidance**—Sperry Gyroscope Co.
- **Tracking and data processing**—Remington Rand Univac.
- **Communications** and countermeasures—Radio Corp. of America. This company will supply the communications-data link subsystem for the Dyna-Soar I.

Second team consists of:

- **Guidance** — Minneapolis-Honeywell. This company recently was awarded the guidance and control subsystem contract for Dyna-Soar I.
- **Tracking — data processing** — Hughes Aircraft Co.
- **Communications** and countermeasures—Sylvania Electric Products, Inc.

Terminal ICBM Defense

Proposals for a contract to build a prototype of a new terminal defense against ballistic missiles known as ARPA Terminal (Arpat) are being evaluated by the Advanced Research Projects Agency and its Institute for Defense Analyses.

Arpat concept, which is a step beyond the Army's Nike Zeus, envisions firing a dart-shaped platform 20,000 to 100,000 ft. into the atmosphere, where it would in turn fire a multiplicity of hypersonic projectiles in random patterns against incoming warheads. Possible advantages of the Arpat technique would be the great number of defensive projectiles, the ability to initiate defense action before the incoming missile's exact trajectory is calculated and the greater likelihood of a hit or deflection.

A series of preliminary three-month study contracts on Arpat were conducted late last year by Lincoln Laboratories, General Electric, Johns Hopkins University's Applied Physics Laboratory, Arthur D. Little, Hughes Aircraft, ACF Industries, Perkin-Elmer, Raytheon, Columbia and Cornell universities.

Companies reported to be working on other aspects of the Boss-Wedge program or studies which will feed into it include Raytheon Co., General Electric's Light Military Electronics Department, Convair Division of General Dynamics, North American Aviation, Douglas Aircraft, McDonnell Aircraft and Martin Co., whose Titan II will be the booster for the initial Dyna-Soar shots. Some of these studies are funded by USAF but others are not.

Outgrowth of Boss-IOC

Present Boss-Wedge program had its origins in the Boss-IOC (bomb orbital strategic system—initial operating capability) study of an unmanned vehicle with ballistic re-entry and a single 24-hr. elliptical orbit. This early effort to determine the military value of space weapons was concluded last September. The Boss-IOC concept was relatively rigid in that it specified a system configuration which had to be studied.

This early Boss weapon system concept was enlarged in a subsequent $140,000 study under Study Requirement 79821 which was awarded to Boeing by WADD last October. Completed recently, this study, entitled Advanced Earth Orbital Weapon System (Low Orbit), is devoted to weapon carrying vehicles on missions below 1,000 naut. mi. from the earth's surface. Three bomber vehicle concepts are considered. These are:

- **Concept A**—Manned vehicle, weapon attached, ballistic re-entry.
- **Concept B**—Unmanned vehicle, weapon attached, ballistic re-entry.
- **Concept E**—Manned vehicle, weapon unattached, winged re-entry.

For each of these three missions, necessary vehicle parameters and subsystems and support systems were investigated. Vehicle aerodynamics, necessary boosters, communications, countermeasures, guidance and computer gear were among the topics of study. A final report on SR-79821 is scheduled for delivery sometime this month.

Shortly after the low-orbit weapon system study was awarded to Boeing, the company was asked by Ballistic Missile Division to undertake another study, Advanced Earth Orbital Weapon System (High Orbit). The study is numbered SR-79822, and dovetails with SR-79821. This six-month, $200,000 Boeing-directed study, to be completed late next month, is another outgrowth of the original Boss concept. It is concerned with vehicles at altitudes above 10,000 naut. mi. The basic Boss-IOC configuration was selected with two specific missions:

• **Concept C**—Unmanned vehicle, weapon unattached, ballistic re-entry.
• **Concept D**—Manned vehicle, weapon unattached, ballistic re-entry.

Roughly three quarters of the SR-79822 effort is devoted to the Boss-IOC idea of a vehicle in a 24-hr. orbit. The remaining quarter is directed toward the ballistic re-entry concepts C and D.

Sandwiched between the high and low orbit earth weapon system studies was a separate four-month, $100,000 study of hardware and subsystems under Boss-Wedge conducted for the Air Force Special Weapons Center. Completed late last year, the study was concerned with such things as system capabilities for space boosters without weight limitations and probable components available during the decade after 1970.

Boeing study teams are about to begin a two-year study of Dyna-Soar III under a $250,000-per-year contract awarded to Boeing from WADD. This effort will involve an attempt to apply to advanced weapon system missions much of the knowledge accumulated during earlier Dyna-Soar II studies. About one-third of the effort will be devoted to a preliminary investigation of the advanced Dyna-Soar III known as Dyna-Mows.

Dyna-Soar III effort will be divided into two parts, the first concerned with:
• **Revising Boeing-Martin** boost glide weapon studies and modifying these results.
• **Selecting up to three** possible missions, such as bombing and support and then detailing them.

The second part of this effort will:
• **Define which equipment** will be needed on the space vehicles selected in part one.
• **Find out which items** will require long research and development periods.
• **Develop an environmental** test program.

The Wedge program, which began in late September (AW Oct. 3, p. 33) and will run through December of this year, is an unfunded, company-backed study in which industry participants are expected to finance their own work. Wedge is an extension of Boss-IOC and is to determine characteristics of second generation vehicles for the following:
• **Non-combat missions,** such as reconnaissance.
• **Manned combat,** presumably bombing missions.
• **Unmanned vehicle** for expendable missions.

Slomar type vehicles are under serious consideration in the Wedge studies. A 50-man Boeing analysis effort completed tradeoff studies of types of orbiting weapon systems which should be maintained in space by a support ferry. Because of the high boost and payload costs, this analysis revealed, it is economically undesirable to use Slomar concepts for vehicles weighing less than 10,000 lb.

Hence, a Dyna-Soar vehicle would be expected to return with its pilot while a larger vehicle might be maintained in space and have its crew replaced in space by a Slomar vehicle, which could return to earth. Slomar concepts are under study at Douglas, Northrop, Martin, General Electric, Lockheed, and Convair.

Navy Plans to Propose Sea Scout Again

Washington—Navy will make one more attempt to get approval to develop the Sea Scout, a family of four solid-propellant satellite launchers that would make use of surplus Polaris missile engines as the submarine-based missiles are retrofitted with improved engines.

Dr. Herbert F. York, former Defense Director of Research and Engineering, refused to approve this and other proposed Navy astronautics projects when the Fiscal 1962 budget was being formulated late last year.

Since National Aeronautics and Space Administration would supply two rocket engines from its Scout vehicle as upper stages for Sea Scout, Navy went as far last February as negotiating a joint program management plan with NASA—apparently in the hope that Sea Scout would be approved during the Kennedy Administration's recent review of the Fiscal 1962 budget requests.

Air Force has for some time had the space booster development mission. It recently was given responsibility for most payload development also (AW Mar. 13, p. 304). To develop Sea Scout and some of the payloads it would launch, Navy would have to gain specific exceptions to these two general rules, through the director of defense research and engineering and the secretary of defense.

Testimony released late last week by the House Science and Astronautics Committee revealed that as late as last Feb. 20, Dr. York still was willing to listen to Navy's proposals on Sea Scout once it had completed discussions with NASA. The project still is not funded in Navy's Fiscal 1962 budget requests.

The testimony indicated that Sea Scout development would have cost the Navy $10 mllion in the first year. It also revealed a number of technical details of the vehicle, which would be launched from ships and possibly from Polaris subs.

Sea Scout family divides this way:
• **Sea Scout I.** This would be a 30,000-lb. rocket, compared with Scout's 36,000 lb., and would be 41-ft. long instead of Scout's 72 ft. But it would put a similar payload into orbit by using the two Aerojet Polaris A1 engines plus the NASA Scout's two upper stages, joined by a simple interconnection.
• **Sea Scout IA.** This would use Polaris A1 motors with improved NASA Scout upper stages now under development.
• **Sea Scout II.** This would introduce the higher thrust Polaris A2 engines now being test fired by Navy as the two lower stages.
• **Sea Scout III.** This would use the still higher thrust Polaris A3 motors now under development.

When the A2 motors have been qualified, Navy told the committee, Polaris A1s in service will be recalled and retrofitted with the 1,500-mi. A2 motors. This would provide about 50 surplus A1s for the Sea Scout program. Later, the A2s in service would be replaced by 2,300-mi. A3 motors and the A2s will be available for Sea Scout.

Capt. Robert F. Freitag, astronautics officer for Navy's Bureau of Weapons, said each Sea Scout would cost from $750,000 to $1 million. Thor-Able-Star boosters launching Navy's Transit satellites cost $4 million apiece, he said.

Twelve Firms Bid On Offshore Launch Study

Washington—Proposals for a preliminary design study of an offshore launch facility for Saturn and other large space boosters were submitted to the National Aeronautics and Space Administration last week by twelve companies, some bidding as teams.

Variety of approaches presented to NASA's Marshall Space Flight Center included floating barges, Texas tower type facilities and land-fills. NASA, as well as Air Force, is investigating sea launches off Cape Canaveral (AW Dec. 12, 1960, p. 60) both to minimize the dangers of large nuclear- and conventionally-powered vehicle explosions and to ease the strain on Atlantic Missile Range facilities.

Companies submitting proposals for the 7,500 engineering-manhour study included: Aerojet-General with Todd Shipyard; American Machine & Foundry; Cal-Val Engineering with Harbor Boat Co. and DeLong Corp. with Ford's Aeronutronic Division.

Further Defense Budget Changes Possible

By Larry Booda

Washington—Defense Secretary Robert S. McNamara told Congress last week that changes recommended in the defense budget are only the obvious major revisions discovered so far, and that "if further changes are found to be essential, we shall propose them promptly to the Congress during the current session."

A comprehensive review of the budget must await a complete reappraisal of the basic national security policies, plans and programs, the results of which may not be fully available for submission to the current session of Congress, he told the Senate Armed Services Committee.

Congressional reaction to the recommended budget changes was generally favorable, but Sen. Richard B. Russell, (D.-Ga.) chairman of the committee, said that unless the North American B-70 Mach 3 bomber program, which is slated for a cut back, is continued as a complete weapon system, he might favor eliminating it completely. He also intends to explore further the decision to delay production and hold the Nike Zeus anti-ICBM missile to a development program, although he was "inclined to go along with Mr. McNamara."

Budget Details

McNamara's statement to the committee gave detailed reasoning beyond the broad outlines of President Kennedy's budget message (AW Apr. 3, p. 26) for program curtailments, cancellations and accelerations:

• **Nike Zeus anti-ICBM** missile system. When the development phase of this controversial system is completed, about $1.75 billion will have been spent, including $863 million through Fiscal 1961 and another $276 million programed for Fiscal 1962.

Explaining his decision to deny funds for pre-production work on certain components, McNamara said: "There still is considerable uncertainty as to its technical feasibility and, even if successfully developed, there are many serious operating problems yet to be solved. The system, itself, is vulnerable to ballistic missile attack and its effectiveness could be degraded by the use of more sophisticated ICBMs screened by multiple decoys. Saturation of the target is another possibility, as ICBMs become easier and cheaper to produce in coming years. Finally, it is a very expensive system in relation to the degree of protection that it can furnish."

• **Nuclear-powered aircraft.** Discussing cancellation of military participation in the Aircraft Nuclear Propulsion (ANP) program, he said: "The direct air cycle system . . . is extremely cumbersome and requires an excessive amount of heavy shielding against radiation hazards. In operation, the system would expel some small fraction of radioactive fission products into the atmosphere, creating an important public relations problem if not an actual physical hazard.

"The indirect cycle system, although requiring less shielding, is an extremely complex engineering task. With over 15 mi. of fine tubing carrying liquid metal at very high temperatures and thousands of welded joints involved, the possibility of a leak constitutes a severe hazard. This design, therefore, does not appear to be very practical for a combat aircraft.

"The ANP project has suffered from chronic over-optimism . . . the aircraft involved would have had little or no military value. It would almost inevitably have been subsonic and limited to an altitude of 35,000 ft."

He added that since there is little prestige value in a project which holds little promise of breakthroughs, and since there is no clear-cut military requirement, the decision was made to discontinue the project, which would have cost another $1 billion for completion of development.

• **North American B-70** Mach 3 bomber. McNamara explained that building a complete weapon system involving subsystems for bombing, navigation, environmental control, automatic flight control, air traffic control and defense coupled with the need for a quick ground reaction time would result in an extremely complex and costly aircraft.

It was decided, he said, to explore, from a purely technical point of view, the problems in flying a large aircraft at great speed and altitudes. If it proved feasible, then the development of a complete weapon system would be ordered.

• **Dyna-Soar suborbital boost-glide** manned aircraft system. Request in the Eisenhower Administration Fiscal 1962 budget was for $70 million. The new request for an additional $30 million makes it the $100 million program the Air Force originally wanted in Fiscal 1962.

• **Discoverer series** of recoverable satellites. An additional request for $16 million has been made, making a total of $36 million for Fiscal 1962.

Revisions in the defense budget submitted by former President Eisenhower have resulted in a new obligational authority request of $43,794,345,000.

Economic effects of the cuts are varied. General Electric Co., which was working on the X-211 direct cycle approach to aircraft nuclear power, has notified 1,100 employes at the Large Jet Engine Department, Evendale, Ohio, that they will be laid off May 1.

Altogether, 2,900 employes work in the General Electric Aircraft Nuclear Propulsion Department, 2,400 of them at Evendale and 500 at the National Reactor Test Station at Idaho Falls, Idaho. The number of these to be retained will depend on what the Atomic Energy Commission decides to do in continuing the work on a materials research basis.

Pratt & Whitney, which was working on the indirect cycle engine at the Air Force-owned Connecticut Aircraft Nuclear Engine Laboratory (Canel) at Middletown, has 735 persons employed on the project there. Another 40 at the Florida Research and Development Center at West Palm Beach also are involved.

Contract Terminations

Contract terminations were announced by the Air Force for the two companies developing the engines, Convair-Fort Worth for the development of a flight test aircraft and Lockheed Aircraft Corp. Nuclear Laboratory at Dawsonville, Ga., which was doing radiation and hazard studies. The AEC also announced contract terminations with the engine developers.

North American Aviation, prime contractor for the B-70, expects little change in employment itself, but four subcontractors will have their workload reduced, and five will have their contracts terminated.

Those reduced will be:

• **International Business Machines Corp.**, Owego, N.Y., which is developing the bomb navigation and missile guidance system.

• **Hamilton Standard Division** of United Aircraft Corp., Windsor Locks, Conn., which is developing the environmental

Polaris Submarine Commissioning Schedule

	(Calendar Year)							
	1960 No.	1961 No.	1962 No.	1963 No.	1964 No.	1965 No.	1966 No.	1967 No.
Five-Per-Year Schedule	2-3	4-6	7-9	10-13	14-18	19-23	24-28	29
New Schedule	2-3	4-6	7-9	10-18	19-29	....	....	....

control and air induction systems.

• **General Electric,** Evendale, which is an associate contractor for the development of the propulsion system.

• **Sundstrand Aviation,** Rockford, Ill., which is developing the secondary electrical power system.

Contracts to be terminated are:

• **Convair-Fort Worth**, fabrication of the YB-70 wing boxes.

• **Lockheed Aircraft Corp.,** Marietta, Ga., development of the upper forward intermediate YB-70 fuselage section.

• **Beech Aircraft**, Wichita, Kan., development of alert pod and associated equipment.

• **Westinghouse Electric,** Baltimore, development of defensive systems.

• **Motorola,** Phoenix, Ariz., development of mission and traffic control (communications) subsystem.

Related Action

In a related defense action, McNamara announced the reduction or discontinuance of operations at 73 defense installations, 51 of which are in the continental U.S. He said that the action was the first resulting from a continuing review of the 6,700 military installations, 4,470 of which are in this country and 2,230 of which are abroad.

Major air installations affected are:

• **Harlingen AFB, Tex.** Training at this base will be shifted to Connally AFB at Waco, Tex. Approximately 2,300 military personnel and 800 civilians are involved. It will be closed by June, 1962.

• **Presque Isle AFB, Me.** Because of the cancellation of Snark missile operations, it will be closed by early 1962. About 1,200 military personnel and 250 civilians are affected.

• **Laughlin AFB, Tex.** Reconnaissance mission will be moved elsewhere in 1962, affecting 2,400 military personnel and 270 civilians.

• **Dallas Naval Air Station.** USAF reserve training will move to Carswell AFB, Fort Worth, no later than March, 1963. Current Air Force facilities will revert to the Navy.

• **Kirtland AFB,** Albuquerque, N. M. Air Force will negotiate with the city for return to full title and control, with the Air Force remaining as a tenant.

Several Air Force-owned plants have been declared surplus and will be turned over to the General Services Administration for disposal. The plants and companies involved are: Plant No. 10, Hawthorne, Calif., Northrop Corp.; Plant No. 30, Indianapolis, Ind., General Motors; Plant No. 69, Pittsfield, Mass., General Electric; Plant No. 29, West Lynn, Mass., General Electric; Plant No. 38, Modeltown, N. Y., Bell Aerospace Corp.; Plant No. 68, Modeltown, N. Y., Olin Mathieson; and Plant No. 32, Williamsport, Pa., Avco Corp.

USAF to Ask Bids On Norad Control System

Air Force request for industry proposals on a command and control system for the North American Air Defense Command's underground combat center (COC), to be built in Cheyenne Mountain near Colorado Springs, Colo., is expected to be released within 10 days.

Bidders briefing conference for the avionics system (425-L) will be held at Norad Headquarters, Ent AFB, in Colorado Springs May 1.

Bids for excavation of the underground COC are due by Apr. 25, and work is scheduled to begin by June 1. The underground COC, slated to become operational within four years, is expected to be able to withstand all but a direct hit from a thermonuclear warhead.

The new underground Norad facility is to be constructed at the 7,000-ft. level on the mountain and will serve as a central command and control facility for air and aerospace defense. The combat operations center, containing situation displays, communications and computer equipment, will be manned by approximately 350 persons on each of three 8-hr. shifts. Up to 700 persons can be accommodated during special alert periods.

Access to the new COC will be via two tunnels, providing for both pedestrian and vehicular traffic. The COC will be housed in a three-story steel structure within a series of intersecting chambers to be constructed inside the granite mountain. Total floor space will be 200,000 sq. ft.

Excavation is estimated to require 12 to 18 months, with another 18 months allocated for construction of the buildings. Installation and test of the command and control system (425-L) is expected to require another 12 months. Army Corps of Engineers will direct the construction program.

Tiros II Photographs Canadian Terrain

Photo taken by narrow-angle camera on Tiros II experimental weather satellite during a clear, cloudless January day shows good ground detail of the eastern part of Ontario, Canada. Town of Cochrane is the white blur within grid at left. National Aeronautics and Space Administration said the grid is not Cochrane's street plan, but a combination of main roads, cleared forest areas and fire breaks. Two small lakes are visible in the lower right, and the wavy line running northeast from the grid is apparently the Abitibi River. Because of timer malfunction, NASA suspended programed remote operation of the wide-angle camera last January. Remote programing of the narrow-angle unit was temporarily interrupted then, but it has been operating continuously since. Both cameras are relaying photos directly on command from ground stations.

First Flight Photo of New Bell YHU-1B

Bell YHU-1B, more powerful version of HU-1A Iroquois helicopter, is seen undergoing flight tests near Hurst, Tex. Most obvious external change over earlier model, now undergoing phaseout, is a taller main rotor mast providing approximately 3.5-in. increase in forward center of gravity limit for an over-all 13-in. range. Container atop rotor mast carries strain gage instrumentation used in test program only. YHU-1B also features 21-in.-chord main rotor blades in place of HU-1A's 15-in. blades, designed to take increased power of new Lycoming T53-L-5 engine, which will be delivering 1,100 shp. later this year; current rating is 960 shp. Maximum gross weight of service HU-1Bs will be 8,500 lb. YHU-1B also features increase in fuel capacity to 165 gal., increase in litter capacity from two to three litters and passenger seating from four to seven.

Reconnaissance Roles Assigned

Washington—Air Force has been assigned its first operational mission in space in connection with reconnaissance satellites and the Army has been given primary responsibility in the establishment and management of a single geodetic and mapping program.

Under a Department of Defense directive (5160.34) issued Mar. 28, each service will continue to make its own maps and charts from the refined data provided by the Army. Thus the decision is a partial exception to the trend of the Kennedy Administration toward single managers for defense programs. The directive was signed by Deputy Secretary of Defense Roswell Gilpatric.

Air Force will be responsible for all research, development and operation of satellite reconnaissance systems. This includes payload design, launch, guidance, control and recovery of all the systems. It also will perform research and development of all instrumentation and equipment for processing reconnaissance data obtained from satellites.

All geodetic data and maps required by Department of Defense activities will be provided by the Army. It will set up and maintain a master geodetic control system covering the world and maintain a geodetic library.

Data collection, regardless of who does which part of it, will be aimed at covering the needs of all the services, and will be performed under broad priorities assigned by the Joint Chiefs of Staff. Army will conduct a research program on basic geodetic methods.

Whenever satellites are intended for geodetic or mapping purposes it will be the responsibility of the Army to set the specifications for the payloads and the operational parameters, but the Air Force will do the research and development for these payloads.

After launching, and recovery the raw data collected by the Air Force will be given to the Army for processing and reduction. It was in this area that a disagreement occurred with the JCS when the proposed directive was being discussed. Air Force did not concur, arguing that data processing should be left with the individual services.

For mapping and geodetic systems other than satellite, the Air Force will perform the research, development and operation when manned high performance aircraft are required. Exception was granted to the Navy for aircraft operations peculiar to the hydrographic needs of that service.

For ground based systems, including instrumented probes and non-geodetic satellite systems, the Army will be responsible for research, development, operation and data processing and reduction.

Similar responsibilities are assigned the Navy in the area of oceanography and geophysical equipment, and operations ashore that are necessary to provide navigation aids at sea. Information will be made available to the Army under its over-all mapping program.

The Army continues to operate Army Map Service, the Navy the Hydrographic Office and the Air Force the Aeronautical Chart Service.

S-60 Test Helicopter Destroyed in Crash

Stratford, Conn.—Sikorsky S-60 Skycrane, fitted with a highly sensitive control system modified for future National Aeronautics and Space Administration VTOL research projects, was destroyed in a crash here last week shortly after takeoff.

The pilots—John F. Porth and Edgar J. Mullins—escaped with minor bruises. The aircraft was being readied for flight to NASA facilities at Langley Field, Va., for the start of the two-month research program.

The modified control system was in the "over-sensitized" condition at the time of the crash, giving control responses of twice the normal magnitude. Pilots experienced control difficulties immediately after takeoff; the S-60 landed hard from a low altitude, broke its right landing gear and rolled over. Fire broke out but was extinguished shortly by a Sikorsky crash crew.

NASA had selected the S-60 for the VTOL research program because its capacity for carrying external loads included placement in both horizontal and vertical planes.

Design Problems, Costs Dampen Supersonic Transport Optimism

By David A. Anderton

New York—Problems of design, construction and operation of a supersonic transport intended to be commercially attractive are now beginning to darken the first rosy glow of optimism that surrounded its conceptual thinking.

Full day's presentation of six technical reports at the Society of Automotive Engineers' National Aeronautic Meeting here and intense discussion led by John Stack, assistant director of National Aeronautics and Space Administration's Langley Research Center, went deeper into the subject than many earlier efforts made by professional societies, and came up with little encouragement and lots of problems.

Seen from a distance, the idea of a Mach 3 transport carrying upwards of 125 passengers over 3,500-naut. mi. cruise ranges seems very attractive. Its potential productiveness is the biggest argument in its favor. But when that argument is modified by the detailed problems of materials, powerplants, operations, aerodynamics, piloting techniques and the many other facets of a sophisticated design, even the most ardent proponents take second looks at their ideas.

• **Engine cost** may be three to four and one-half times the cost of today's jet powerplants for subsonic cruise, said W. H. Sens and T. G. Slaiby, of Pratt & Whitney Aircraft division. Program development cost could be two to four times that of a subsonic-cruise turbojet.

• **There is no long-life material data** for the design of a structure intended to have a useful life of 30,000 to 50,000 hr., said W. F. Brown, Jr., G. B. Espey and M. H. Jones, of NASA's Lewis Research Center. There is no data on stability of properties over even a 10,000-hr. span, Brown added, and new—and generally deleterious—effects on structural strength are being found in every extension of current data by tests simulating long-time flight at supersonic cruise speeds.

• **It is premature to pick** the cruise speed or the type of powerplant, agreed engineers from General Electric Co.'s Flight Propulsion Division and Pratt & Whitney. No current engine is suitable, they said.

• **Military airframes and powerplants,** while advancing the state of the art, can't be applied directly to the problem, stated NASA's Mark R. Nichols of Langley Research Center. But at least they point the way to reaching high efficiency during supersonic cruise.

But Nichols, whose presentation was a composite view of the NASA group working on the problem, did hold out some hope. The combination of a variable-geometry wing and a hybrid powerplant of the turbofan-ramjet type make possible major advances in mission flexibility and efficiency, he said.

NASA's variable-sweep wing studies have been pointed toward the optimum combination of high- and low-speed flight regime characteristics. The pivoted wing panels swing forward to an aspect ratio of eight or so for the low-speed takeoff and landing approach phases of the flight, and tuck back toward the tail to a short-span configuration with an aspect ratio around two for the supersonic cruise phase of flight.

Initial testing of typical variable-geometry configurations show gains over fixed-geometry layouts which were characteristic of earlier proposals for supersonic aircraft, but Nichols pointed out these studies have not yet progressed to the point where cruise performance and weight penalties can be assessed.

Four engine configurations were suggested by the NASA scientist: turbofan of low bypass ratio and with duct burning, a turbofan-jet, which is a turbofan engine surrounded by a ramjet for supersonic cruise; a lightweight turbojet with afterburner; and a turboramjet, a combination powerplant using a ramjet shell around a turbojet.

Nichols suggested that the straight turbofan seems to be best up to Mach 2.5 cruise speeds, and that above that, the turbofan-jet appears to be best by a wide margin. But extensive analysis is needed, he pointed out, in words that had been said in many ways by most of the speakers during the day.

Assuming four turbofan-jets and the variable-sweep wing, NASA calculations for the Mach 3 cruise transport show that a 30,000-lb. payload aircraft could be built for about 350,000 lb. takeoff weight. It would have a takeoff speed of 150 kt., accelerate through sonic speed at 45,000 ft. to minimize sonic boom effects, and carry fuel reserves of 17,000 lb. This transport would fly the 3,500-naut.-mi. mission from present-day airports.

Other detailed problems:

• **Restarting the inlet-engine** combination following flameout or surge without needing to decelerate and then reaccelerate the airplane.

• **Maintaining off-design flight** efficiencies high enough to fly to original destination at subsonic speeds and lower altitudes in the event of trouble.

• **Intensity of the sonic boom** at the lower cruise altitude of a Mach 2 airplane might be the best valid reason for going to a Mach 3 cruise speed. In either case, the airplane is in serious trouble during altitude acceleration, having to fly at 42,000 ft. at Mach 1.2 and climb to 50,000 at Mach 1.4.

• **Surface finish of the quarter-acre** of skin on the airplane must be held so that roughness does not exceed 0.008 in. (three times the thickness of this paper) to avoid drag penalties.

• **If the necessary artificial** damping system fails, the airplane must be flyable by other means. This is extremely difficult with the changes in inertia distribution dictated by drag considerations.

NASA's W. F. Brown, Jr., suggested that the rational approach to the materials problem now was to try to narrow down the field of available metals to what he called "candidate" alloys. The major reason, he said, is that there is such an enormity of unknown characteristics of all the alloys available to a designer that there simply is not time enough to do optimizing studies across the board. Instead, he advocated selecting a few based on their properties established by certain key tests, and then developing the complete body of test data only for those candidate alloys.

This means the closest cooperation between the materials engineer and the designer early in the game, Brown emphasized, and this can't be done with any kind of a crash program; it's a long-term venture.

W. H. Sens, who presented the Pratt & Whitney report, said that he preferred the turbofan with duct burning as a supersonic powerplant, based on the company's experience with its afterburning powerplants plus running its forward-fan engine with duct burning.

One difficulty Sens pointed out was that of testing engines for the supersonic cruise case. Subsonic-cruise powerplants experience their most rigorous regime on the ground at takeoff, he said, and that's easy to simulate on the test stand. But the attainment of test conditions corresponding to supersonic flight at high altitude is another matter involving extensive facilities. This is one major reason for the increased cost of an engine development program.

The engine itself would cost more by several multiples primarily because of the increased cost of the materials involved. Sens said every part in the engine would be working at temperatures on the order of 500F higher than in the subsonic cruise case. Fuel and oil costs would increase in order to guarantee stability of properties at these elevated temperatures, and a few cents per gallon more for fuel would increase the direct operating cost noticeably (50%, said another speaker).

Oil for a Mach 3 engine now costs $100 per gallon, Sens said.

Sonic Boom Phenomena Affect Design of Supersonic Transports

New York—Major unknown factor in commercial supersonic transport operations may be the extent to which sonic boom phenomena will control design, according to engineers of Pan American World Airways. J. G. Borger, chief project engineer, in collaboration with L. H. Allen, Jr., N. D. Folling and W. F. Hibbs, raised the question of whether the supersonic transport will be able to fly anywhere in the world or will be confined by the boom problem to overwater operation.

Many design decisions, the Pan Am engineers said, depend on the altitude at which transition is made from subsonic to supersonic flight. This altitude in turn may depend on the sonic boom limitations. The assumption is made that the aircraft will not have to fly subsonically over land except in climb or descent—but if this thinking proves optimistic, the assumption will have to be changed. More research is needed in this area.

Two other "great unknowns," the Pan Am engineers told SAE members meeting here (see p. 31), are configuration and powerplant. Configuration alternatives seem to be a delta wing with canard type longitudinal control, or variable geometry wing. Powerplant trend seems to be toward a "rather complex" turbofan with duct burning.

Probable Requirements

As an indication of what the airlines will want if and when they buy the supersonic jet, the Pan Am engineers listed some probable requirements:

- **Size can not be specified** this early, but in all probability the supersonic plane won't be smaller than present jets. The aircraft should be sized for competition, i.e., contain enough seats. Later stretch possibilities should be designed into the early versions.
- **High frequency potential** will be necessary for economic reasons.
- **Mach 3 speed** is the present thinking. It's better to have an airplane capable of this speed regime even if it is operated slower at the start, than to buy one forever limited to Mach 2.
- **Passenger comfort** should not be sacrificed to speed.
- **Range should be competitive** with subsonic transports, whose range approaches 5,000 mi.; therefore, the supersonic plane should have a range of 4,500-5,000 mi. It might be possible to manage with 3,500 mi. if enough growth potential was built into the design.
- **Operationally, the transport** should be able to step climb; to operate with high temperatures en route and at airports; should possess superior flying characteristics with no "idiosyncracies" which could surprise the pilot; flying characteristics should be along fairly familiar lines since no airline can afford to develop a "special team like the astronauts" for its supersonic transport; should really fit into present airports—with certificated takeoff on a 10,000-ft. runway at sea level on 90F day, and land in 7,500 ft.; should be of a design directed toward all-weather capability.

Other qualities the airlines would like in a supersonic transport, as indicated by the Pan Am study, include six abreast seating cabin width, 130-kt. landing speed, interior arrangement flexibility, about 50,000-hr. life expectancy, a competitive life of 10 yr.

The Pan Am engineering team simulated Mach 2 transport operations over much of the airline's route structure, using an IBM 705 computer. Boeing study aircraft of 400,000 lb. gross takeoff weight was the model. They concluded that, in this case, economics of the supersonic transport do not yet match those of the subsonic jet.

Among the comparisons derived from this study was Mach 2 economics expressed as a percentage of subsonic economics. Results showed number of aircraft, 48%; total investment, 129%; fuel cost, 152%; total direct cost, 111%; indirect cost, 92%; operating expenses, 100%; passenger revenue at 60% load factor, 99%; cargo revenue at 40% load factor, 47%; total revenue, 92%; operating profit, 38%; interest charge on investment, 129%; net operating profit, 29%; annual return on total investment, 22%.

Added Aspect

In another aspect of the study, it was found that an operating time limitation, for noise or other reasons, could cut the Mach 2 plane's production by about half in a New York-London service. This would raise direct costs about 30%, double the required investment in equipment, and necessitate a fare increase of some 10%—not allowing for interest on the additional investment. These figures assume the supersonic service would be limited at Idlewild and London to the hours between 8 a.m. and 10 p.m.

According to the Pan Am engineers, a real advance in ground handling times and techniques will be a major adjunct of successful supersonic transport operation.

Performance Problems

Designers of the supersonic transport were asked in another SAE presentation to solve performance problems without prejudice to the handling qualities of the aircraft throughout the flight regime.

Fully automatic flight control for a whole flight is many years away and not really necessary, according to W. W. Moss, Pan American; J. R. Gannett, Boeing Airplane Co.; and P. H. Patten, Douglas Aircraft Co. Terminal area operations of the supersonic aircraft will be essentially the same as today, and human control should be perfectly feasible. Present stability and control criteria appear to be valid as far as they go, except in certain areas. Any electronic or other means of augmenting stability should possess a level of reliability comparable to that of the basic control system.

Passenger density, according to Paul Shipps and James Frick of Convair, is a design factor which perhaps should be more carefully considered in supersonic transport development. Big savings in direct operating costs can be gained by increasing passenger compartment density. One cubic foot of passenger compartment volume is equivalent in cost to 13.5 lb. of payload or 10.7 lb. of airframe weight.

Halaby Calls for Cost Cutting

New York—About 20% of the costs of building a supersonic transport could be saved by improved cost-consciousness in manufacturing, Federal Aviation Agency Administrator Najeeb Halaby told Society of Automotive Engineers members here.

Halaby said the United States aviation industry can't afford to go into supersonic transport development under present techniques which involve unnecessarily high overhead costs. He challenged the engineers to help with a "lean, mean, austere" approach to production which would emphasize cost consciousness and creative methods of finding economic efficiency.

Major question now in supersonic transport development, Halaby said, is whether we should seek the technologically possible airplane—Mach 3 to 5, cruise in excess of 75,000 ft., 125 or more passengers, 3,500 or more nautical miles—or take an interim step. Not enough is known to decide the question yet, Halaby said, but he is seeking the "missing pieces" on which a decision will be based.

NASA Pushes International Prestige Goal

By Edward H. Kolcum

Washington—Drive to exploit current international potentials of space has begun as part of the Kennedy Administration's effort to rebuild U. S. prestige by non-military means.

The emphasis involves no specific money increases to support foreign scientific projects, but rather consists of more direct top level contacts and much earlier notification to foreign scientists of U. S. space plans.

Objective is to bring as many countries as possible into U. S. space plans now, so that the practical applications in weather, communications and navigation satellites will be global in sponsorship and will help strengthen the peaceful U. S. image abroad through demonstrated scientific superiority.

Recent agreement calling for British and French participation in National Aeronautics and Space Administration's communications satellite research and development program is a sign of the expansion of joint space programs beyond the scientific area and into the realm of practical application.

James E. Webb, NASA administrator and a four-year diplomatic veteran as under secretary of state, told AVIATION WEEK that the international program is one of his major missions in the agency.

It was no secret that President Eisenhower reluctantly backed the U. S. space program, and that he felt the prestige value of space accomplishments was vastly over-rated. The Eisenhower Administration essentially felt that Russia had reaped the fruits of any prestige available in space.

Subtle Policy Change

Although some observers argue that the space budget would have to be tripled over its current billion dollars to surpass the Soviets quickly, Webb said the subtle change in White House thinking is a recognition and understanding by both President Kennedy and Vice President Lyndon Johnson of the prestige value of space.

The Kennedy Administration, Webb said, believes what the U. S. is doing in space will yield more solid benefits than the Soviet program. The NASA administrator's big job is to sell this idea as one way to reduce what has been complete U. S. reliance on military forces for international stature.

Webb views the NASA mission as having three basic parts:

- **Retain technological superiority** by accumulating more basic knowledge through scientific experiments.
- **Apply this knowledge** in civilian uses such as weather and communications satellites.
- **Demonstrate to the world** that the U. S. leads in scientific knowledge by mutual participation in practical experiments.

This philosophy "does not depend on the acquiescence" of another country, Webb said, in an obvious reference to difficulties in maintaining foreign bases. The U. S. plans to conduct the experiments, and has opened the door for participation by others.

Key to the way this is being done is the shuffling of responsibilities in the NASA top staff. Dr. Hugh L. Dryden, deputy administrator, has been relieved of much of his day-to-day management responsibility to spend more time in direct dealings with foreign scientists. General management of the agency's technical programs has been shifted to the associate administrator, Dr. Robert C. Seamans, Jr.

Webb's Role

Webb himself will deal directly with the State Department to get bilateral and multilateral programs under way. Webb intends to rely on Dr. Dryden and Dr. Seamans for scientific judgments. One of the most frequent criticisms of NASA during the previous Administration was that engineering and scientific decisions were made from a political viewpoint by officials who did not understand the technical problems.

Webb points to his State Department and general background (AW Feb. 6, p. 29) to prove his knowledge of forces which influence world opinion, and he said NASA will not support empty gestures or stunts in cooperative programs. There will be no general dollar exchange, but U. S. will help finance projects which it considers necessary for a complete space program —projects which would have been conducted anyway without foreign participation.

The United Nations Space Conference, the first official space venture under sponsorship of many nations, continues to have its political problems in getting under way. But the U. S., through NASA, has firm cooperative projects with eight nations, some with payloads already being built.

The U. N. conference is being stymied by an inability to schedule a committee meeting in which the time, place and conference agenda would be established. Present makeup of the U. N. committee is 12 western nations, seven countries in the Soviet bloc and five nations considered neutral. Russia has insisted on equal East-West representation, which means the western participants would have to be reduced to seven.

Change in Emphasis

Most of the existing U. S.-foreign agreements in space were initiated under the Eisenhower Administration, but Webb feels the distinction will lie in the emphasis and pace with which the projects move. Policy decisions will be made quickly by senior Administration executives—by telephone, bypassing the bureaucratic layers of interdepartmental committees and acting without having to wait for a White House decision.

This is possible, Webb said, because of President Kennedy's insistence that the executive agencies conduct their own programs and make their own decisions. Abolishment of the Operations Coordinating Board, he said, is an indication of the President's philosophy.

Webb foresees expansion of the number of projects in the international space field, and he said several bilateral discussions have been started recently.

Most significant action since the Kennedy Administration took office was an agreement with Britain and France to build ground stations for NASA's active and passive communications satellites. The agreement was a tacit indication that the U. S. commercial communications satellite program will include financial support by the British General Post Office and the French Center for Telecommunications, both government communications carriers.

Additional nations have been invited to take part in the communications satellite development program, which is aimed at finding the best commercial system. Ultimate system will be selected after demonstration flights by the active Relay system, to be launched next year; multiple-sphere passive Rebound system, to be launched in 1963, or the synchronously-orbiting Advent satellite, being developed by the Army.

Late last month, NASA signed a joint agreement with the French Committee for Space Research calling for

Nerva Bids Submitted

Washington—Bids for the National Aeronautics and Space Administration's Nerva nuclear space propulsion system were submitted last week by Aerojet-General, American Metal Products Corp., General Electric, Pratt & Whitney, Rocketdyne, Thiokol and Westinghouse. Contract award is expected to be made early in May. Nerva is the flight engine that will be developed under Project Rover.

joint sounding rocket and satellite launches, information exchange and exchange of scientific personnel (AW Apr. 3, p. 33).

In another recent cooperative move, the U.S. and Italy have agreed to launch sodium flares simultaneously from Wallops Island, Va., and Sardinia to study variations in location of wind shear and direction. The experiments will start late this month or in May.

Agreement similar to that signed by U.S. and France is expected soon between U.S. and Japan, which recently sent a task group to this country to discuss sounding rocket and satellite experiments.

Norway, constructing a sounding rocket launch site in the Lofoten Islands, has held discussions which could lead to use of U.S. rockets containing Norwegian ionospheric instruments in a series of launches beginning this fall.

Sweden and Argentina also have discussed general sounding rocket programs with NASA, and a technical group from Argentina recently visited Wallops Island to observe the NASA sounding rocket installations.

Firm commitments were made early last year with Britain and Canada for the U.S. to provide launch facilities and vehicles for satellite instruments being built in those countries.

FCC Begins Exploratory Probe Of Communication Satellite Issues

Washington—Federal Communications Commission has launched an inquiry into new administrative and regulatory questions raised by the prospect of commercial operations with communication satellites.

The move reflects growing uncertainty in some government circles over the chosen-carrier implications of space communication systems. Because of the heavy initial investment required, radio spectrum limitations and the demand for such facilities anticipated in the near future, many observers believe that only one, or at most two, commercial systems could be justified in the foreseeable future. The FCC inquiry is based on this premise.

The commission has asked industry, including the communication common carriers, to detail their views on how commercial space communication systems should be owned and operated, within the framework of existing laws and policies, or how such laws would have to be modified to accommodate their proposed plan.

Companies, which are to submit their views by May 1, also are asked to state whether they intend to participate in the proposed plan and the extent of their participation.

American Telephone & Telegraph Co. has indicated publicly its intention to proceed with development and implementation of a commercial space communication system, using private capital, providing it obtains government authorization. The decision of others may depend upon which company is selected by the National Aeronautics and Space Administration to develop its Project Relay communication satellite, since this would give the contractor a lead over competition.

The prospect of a single commercial space communication system, at least initially, FCC said, raises the question of maintaining the U.S. policy of fostering beneficial competition among privately owned and operated international communication common carriers and of operating within the framework of existing anti-trust laws.

The purpose of the new inquiry, the commission said, is to determine various methods by which all interested international communication common carriers and others can participate "on an equitable, non-discriminatory and lawful basis."

In a statement volunteered by AT&T shortly before the recent FCC action, the company said it did not wish to exclude other international carriers either from establishing such systems or from sharing the use of the system proposed by AT&T. "We seek only the opportunity to employ private initiative, management and capital in the public interest and under public regulation in a manner wholly consistent with traditional public policy with respect to international communications."

The Bell System said its proposed space communication system facilities would be made available to all international communication carriers serving the U.S. for any services they now are, or may in the future, be authorized to provide by the FCC. Participation by other companies would be made available on an equitable basis either by ownership participation through prorate sharing of the capital investment and operating expenses or by lease arrangement. AT&T now leases some circuits on its transatlantic telephone cable for use by international telegraph companies.

Some observers see this latest AT&T offer as a concession to the idea of a system owned and operated by a combine of companies, as a means of avoiding the charge of a private monopoly in space. The offer also may have been sparked by the recent proposal of Lockheed to form a "common-carrier carrier" combine for a space communication system (AW Mar. 20, p. 28.).

The FCC is now seeking the views of other common carriers and interested companies, asking for their suggestions for the best plan of participation to operate a space communication system within the framework of existing policies and laws. The commission raises the question whether such a plan should include participation by manufacturers of satellite communication and launching equipment. Industry is asked to specify in detail the financial and operational arrangements of the plan they propose.

The burden is placed on industry to specify how proposals would comply with existing provisions of the Communications Act of 1934 and applicable anti-trust statutes. Where a proposed plan does not comply, the company is asked to recommend specific changes that would be required in these laws to permit adoption of the plan proposed.

FCC also asks for a statement of the extent to which each of the several parties to the plan would be subject to regulation by the commission as common carriers or otherwise.

Bambi Contractors

Air Force has decided to award study contracts for interception of ballistic missiles in the boost phase under Project Bambi to General Dynamics Corp.'s Convair Division and to Space Technology Laboratories, Inc. A third study contract for approximately $3.5 million will be awarded to one of the other firms in the competition, being sponsored by Advanced Research Projects Agency, Air Force's Ballistic Systems Division and Aerospace Corp.

Competitors include, in addition to Convair and STL, the team consisting of North American Aviation, Raytheon, Electro-Optical Systems and International Business Machines Corp.; another team composed of Hughes Aircraft, McDonnell Aircraft, Avco and United Technology Corp., Boeing Airplane Co. and RCA also is bidding. The Hughes team is believed to be favored for the third study contract.

Convair also is engaged in a funded Air Force study in a relevant field under Project Spad, for satellite protection for area defense, which is related to ballistic missile interception in its trajectory during boost. STL has been performing analyses under studies related to random barrage system of interception. In the Bambi competition, Convair has been assisted by Aerojet-General and Burroughs.

Fairchild Records $6-Million Loss

Fairchild Engine and Airplane Co. reported a net loss of $5,994,650 for 1960, most of it due to additional write-downs on the F-27 turboprop transport which still is in production on a limited basis.

The F-27 line was shut down briefly last fall, but four aircraft now are under construction without specific orders for them and a limited number may be built after that.

Of five airplanes built last year without orders, four have been sold in the last four months.

The F-27 write-down of $5,200,000 was made on the basis that the airplane could not be sold at an inventory profit at current prices in quantities now contemplated.

With the write-down, the company expects at least to break even on any 1961 sales.

Remainder of the write-down covers anticipated losses on various military subcontracts. The company's major subcontract program, for B-52 subassemblies, was not involved.

Following the policy enunciated last year with the change in top management of the company calling for cutbacks to reduce overhead, non-aerospace projects such as International Aluminum Structures, Inc., aluminum bridges; Jonco Aircraft Corp., builder of F-27 assemblies at a plant at Shawnee, Okla.; Armalite Division, lightweight sport and military rifles, and the Plastics Branch were sold or closed.

Seeks Defense Business

Edward G. Uhl, Fairchild's new president, told stockholders that Fairchild would concentrate henceforth primarily on defense business and would seek to diversify the technical skills of the company rather than its products. The former method not only requires less capital, but more suits the character of the industry today, he said.

Early this year Fairchild arranged a new line of bank credit for a maximum of $12 million. Chase Manhattan Bank of New York is now the lead bank of a group of five, and Bankers Trust Co., formerly the lead bank, has dropped out of the lending group along with two others.

Fairchild sales totaled $85,096,896 in 1960 compared with $114,068,426 the year before. The company reported a $1,515,261 profit in 1959, but had posted a $24 million net loss the year before.

Net worth dropped to $15,578,242 from $21,572,892 the year before as a result of the new write-down. Backlog at the end of 1960 was $43 million compared with $76 million the year before.

Other financial reports:

• **General Precision Equipment Corp.** reported net profit of $5,312,692 or $3.46 a share on sales of $224,427,566 in 1960. Figures for the year before were $4,198,200 profit, or $2.63 a share on sales of $215,588,430.

Lofti Tests Confirm Space Uses for VLF

Washington—Possibility of using very low frequency (VLF) radio for space vehicle guidance and for communication with submerged submarines via a satellite relay has been confirmed by results of recent tests using Naval Research Laboratory's Lofti satellite.

The satellite, launched Feb. 21 in a piggy-back experiment, failed to detach itself from Transit IIIB and the final booster stage, but it operated for about six weeks before being destroyed upon re-entry.

Limited analysis of Lofti data to date indicates that VLF waves (3-30 kc.), partially penetrate the ionosphere as well as being reflected from it, confirming previous theory. Signals transmitted at VLF from a ground station in the Panama Canal Zone were retransmitted by the satellite at VHF frequencies to NRL mobile and National Aeronautics and Space Administration ground stations.

Ability of VLF signals to penetrate water and ice to moderate levels has prompted their use by Navy for submarine communications, but has required extremely expensive and powerful ground stations to achieve global coverage.

New data suggests feasibility of using lower-power stations for transmission to a distant satellite which would rebroadcast at VLF to submarines in its vicinity.

NRL scientists report that data analyzed so far indicates that VLF waves travel at less than the speed of light, the velocity at which all higher frequency radio waves are thought to travel.

Velocity depends upon signal path geometry and local ionospheric conditions, data indicates.

Another observation, of secondary pulses delayed as much as ⅔ second from primary pulse transmission, suggests they are echos which travel along the earth's lines of magnetic force from northern to southern hemisphere and back.

Naval Research Laboratory plans to launch three or four more Lofti satellites, including vehicles capable of transmitting and receiving at VLF frequencies.

News Digest

Trans-Canada Air Lines completed a precautionary inspection of landing gear assemblies on its fleet of eight Vickers Vanguard aircraft last week, less than 48 hr. after one of the transports was forced to make a belly landing at Montreal Apr. 1 because the right main gear failed to descend. Problem was traced to failure of the right wheel truck to position properly, jamming the gear doors. No malfunctions were discovered on the remaining Vanguards.

Air Force is transferring 16 C-130s from the 839th Air Division, Sewart AFB, Tenn., to the 322nd Air Division, Evreux AFB, France to supplement present airlift capability in Europe and to provide Tactical Air Command fighter units there with inter-theater airlift.

Bell 47G-3B, powered by Lycoming TVO-435 piston engine containing an AiResearch T-11 exhaust-driven supercharger, will be marketed by the Ft. Worth, Tex., helicopter manufacturer in May. This model replaces 47G-3 due to further unavailability of Franklin supercharged engines. Sea level performance to more than 15,000 ft. is claimed for new aircraft at maximum gross weight of 2,850 lb., which is some 300 lb. greater than the earlier 47G-3.

Nord Aviation has an $86,000 Air Force design study contract to determine the characteristics of a turbojet-ramjet powerplant. The French firm has explored the dual propulsion field with its Griffon research aircraft.

Northwest Airlines last week reported 1960 net earnings of $1.6 million, compared with a 1959 profit of $5.7 million. Gross revenues of $123.3 million were down 2.1% from those of the previous year.

Trans World Airlines earned a net profit of $6.4 million from both international and domestic operations in 1960, compared with a net profit of $9.4 million for 1959. Gross revenues reached $378.3 million, an 8.6% increase over 1959. Operating expenses for the year climbed 9.4% to $362.3 million.

General Electric Missile and Space Vehicle Department will conduct a $100,000, one-year National Aeronautics and Space Administration study of the feasibility of a magnetohydrodynamic electric engine for space applications.

FAA Re-evaluating Radar Handoff System

Agency reappraising Hazeltine TV marker device under spur of pressures from midair collision.

By David H. Hoffman

Washington—Federal Aviation Agency, responding to pressure generated by the Dec. 16 midair collision over New York, plans to revive its evaluation of a radar handoff system designed to help keep aircraft under uninterrupted ground radar surveillance during letdowns and approaches.

The decision to reappraise the relatively simple but long-shelved system is a departure from FAA's general concentration on developing the automatic systems which will be required for future traffic control, a concentration which has given current state-of-the-art improvements a relatively minor role.

By attaching a television marker to a given target, even though the target appears on more than one radar scope, the system will furnish air traffic controllers with an electronic aid in executing radar handoffs. Thus, radar surveillance need not necessarily be interrupted when an inbound aircraft flies from airspace monitored by an Air Route Traffic Control Center (ARTC) into airspace monitored by airport approach controllers.

During just such an interruption last winter, a United Air Lines DC-8, en route to New York International Airport, overshot its clearance limit and collided with a Trans World Airlines Super Constellation (AW Jan. 16, p. 38). The crash, which killed 128, focused congressional attention on the critical radar gap between most U.S. center and approach control facilities and on radar handoffs in general.

The TV radar handoff system (TRHS) was conceived by Hazeltine Technical Development Center engineers almost three years ago. It was once the cornerstone of an FAA study aimed at determining how controllers could best pass an aircraft from one ARTC sector to another, or from ARTC to approach control, without losing radar contact. It was also the subject of Hazeltine's detailed Technical Proposal 6003 to the FAA, dated Mar. 15, 1960.

When FAA's Technical Development Center at Indianapolis closed in June, 1959, the original study was scrapped. Thereafter, fiscal priorities drafted by the Agency's Bureau of Research and Development ruled out a reinstatement until Feb. 17, 1961, date of the present $170,437 contract with Hazeltine. Of this, $149,721 is for hardware, $20,716 for study and field installation.

On Feb. 20, Sen. A. S. Mike Monroney (D.-Okla.) opened his Senate Aviation Subcommittee air safety hearings. During the two-week session, Sen. Monroney urged FAA to strengthen the radar coverage offered aircraft approaching terminal areas in the light of deficiencies disclosed by the New York collision (AW Feb. 27, p. 41).

"It seems to me," Sen. Monroney said, "that we're in such a great rush to accommodate a large volume of traffic that we do less than is humanly possible to be certain that planes are in their right positions." In the traffic congestion that results, "Radar has no time to watch for a possible overflight of a vital point, even though it may mean life or death for 100 or more people."

Hazeltine believes that it can easily deliver all components needed to evaluate TRHS before Nov. 1, the purchase contract's deadline. BRD testing at FAA's Atlantic City, N. J., experimental center probably will take an additional eight weeks. First production contracts, therefore, cannot be expected before January or February, 1962, even if FAA's Bureau of Air Traffic Management approves the evaluation prepared by BRD.

As envisioned by Hazeltine, the TV radar handoff system will involve these major components and functions:

- **Dual axis control stick.** Using this control, or "joy stick," the controller who would make the radar handoff pinpoints the appropriate aircraft's blip by positioning alpha-numeric characters or symbols beside it on his scope.
- **Coordinate translator.** This device converts the geographical coordinates of a target on one TV display to identical coordinates on another. With some sacrifice in accuracy, target data can be relayed to repeater scopes fed by a separate antenna system.
- **Character generator.** By deflecting the beam of a small monoscope, this produces the symbol associated with a given target. The same symbol would appear simultaneously on the two scopes, or repeaters, involved in a radar handoff.

Western Plans Turbofan 720B Flights in June

Western Air Lines' first turbofan Boeing 720B takes off from Boeing's plant at Renton, Wash. Western has ordered four of the medium-range transports and expects to begin scheduled 720B flights next month. The airline is now operating two 707s leased from Boeing. Four Pratt & Whitney JT3D-1s (17,000 lb. thrust) boost cruise speed to more than 600 mph. (AW Mar. 20, p. 67).

• **Telephone encoder and decoder.** As the control stick is positoned, the encoder develops two audio signals which fix the target's location. These are fed to the decoder through ordinary telephone circuitry. The decoder translates the frequencies into voltages that actuate either the translator or character generator.

By supplementing aids already installed in towers and center IFR rooms, use of the TV radar handoff system is expected to cut the volume of conversation routinely required of controllers working traffic. Presently, a receiving controller may be warned of an aircraft flying into his area by interphone, squawk box or signal lights. Flight progress strips and beacon returns might be used to furnish additional information. With TRHS available, identification, under certain circumstances, might be sufficiently precise to warrant a radar handoff without detailed verbal descriptions of the target involved.

Despite its revived interest in the system, FAA is aware that TRHS possesses some significant operational handicaps. For example, TRHS alone does not solve the slant range error ambiguity inherent in an aircraft sighting taken from two different radars. Lacking its own source of altitude information, TRHS cannot cope with the crisscrossing blips in a crowded holding pattern. Nor can it distinguish between two aircraft flying over the same point at different altitudes.

According to R. L. Sorensen, Hazeltine's electronic design supervisor, TRHS will serve as a "good guide for controllers" attempting to pass an aircraft from one radar system to another. But if other targets are in close proximity as the changeover takes place, the inter-radar handoff is seldom positive, he said. Controllers in this situation must consider the target's course and speed or perhaps call for a turn to establish positive radar identification.

One advantage of the system underscored by both FAA and Hazeltine is its ability to operate within the realm of scan converted radar displays. Scan conversion—which stores the display temporarily illuminated by the rotating trace of a standard radar scope and renders it suitable for TV reproduction—will be installed in most major ATC facilities within the next few years.

The TV screen shows a constant picture, completely independent of radar acquisition time. Video markers can be moved at will across the TV picture's face without leaving permanent smears. At the same time, marker intensity can be controlled. The result is a system well suited to the transfer of target data between the TV displays of two different radars, or two different range scales, or decentered displays from the same radar, Hazeltine says.

Carriers Focus on Own Problems As TWA-Northeast Pact Expires

Washington—Prospects for a Trans World Airlines-Northeast Airlines merger are growing dimmer as TWA reviews its management policies under a new president and Northeast concentrates on permanent renewal of its New York-Florida operating authority.

Completion of a $300-million equipment financing deal by TWA, along with the selection of several new directors, has set the stage for a complete reevaluation of the merger proposal, approved earlier by the board of directors of Northeast, but delayed by TWA pending the completion of financial arrangements for its future fleet expansion.

TWA requested that the deadline for a final decision on the proposed merger be extended until June 30 to permit further study by its new management.

TWA suggested that such a study could best be accomplished by a "recognized transportation consultant" to determine the over-all effect of the merger on the international carrier's operations and earnings.

Charles C. Tillinghast, who assumes the presidency of TWA on Apr. 17, has stated that he intends to thoroughly explore the merger idea to make sure that it offers more to the airline than merely a means of increasing its size.

Second Request Refused

Northeast, which earlier agreed to move the merger decision date up from Jan. 31 to Apr. 1, refused to grant the second request on grounds that it "could no longer remain in a position which does not permit us a complete freedom of action." However, the airline added that a merger would "serve the best interests of both corporations in many respects."

Meanwhile, Northeast is citing its fleet of six Convair-880 turbojets, leased from the General Dynamics Corp. and General Electric, as one of the major reasons why the Civil Aeronautics Board should give the carrier permanent operating rights on the New York-Florida route over which it was certificated temporarily nearly five years ago.

"We have the management, aircraft and know how . . . and have successfully weathered the burdensome transitional years," the airline argued in requesting renewal of its authority on the route, which expires in November.

Northeast's six 880s are part of Hughes Tool Co.'s 30-aircraft order, placed with General Dynamics' Convair Division for TWA. They were leased by Northeast—from General Dynamics for the airframes and General Electric for the CJ-805-3 powerplants—over a seven year period with an option to purchase.

Last week, General Dynamics was negotiating with Nelco Inc., for the possible purchase of the leased airframes under terms which would permit Nelco to continue their lease to Northeast. Nelco is jointly controlled by Aviation Financial Services, Inc., and the Equilease Corp., a subsidiary of Electric Auto-Lite Co. Lease of the Convair 880s' engines would continue under a separate agreement with General Electric.

In addition to the Convairs, Northeast is leasing a Boeing 707 which will be returned to TWA by May 1, and also operates a fleet of 10 Vickers Viscounts, 10 Douglas DC-6Bs and 6 DC-3s.

To aid Northeast's transition to turbojets, the Hughes Tool Co. has also loaned the airline a current total of $8 million in the form of unsecured and subordinated notes, covering the integration of the Convairs into its fleet, spare parts and working capital. In addition, the Atlas Corp., which has a controlling interest in the airline, has invested $20 million in Northeast during the past five years, according to James W. Austin, president of the airline.

Defending Northeast's right to continue in the Florida market, Austin told CAB that the airline's current aircraft fleet is valued at $40 million, compared with only $2.5 million when the carrier was certificated between New York and Florida.

Despite early problems in acquiring new equipment and facing heavy competition over the route, Northeast's share of this traffic market has climbed from 97,113 passengers carried in 1957 to 281,854 in 1960 and is expected to reach 400,000 by the end of this year, Austin said.

As an example, he cited the average load factor of 66.3% which Northeast realized with its leased Boeing 707 last year on a single daily round-trip schedule which carried 68,000 passengers between New York and Miami.

Competing against Eastern Air Lines and National Airlines between Boston and Florida points in 1959, said Austin, Northeast carried 38% of the Miami traffic, 26% of the Tampa traffic and 13% of the Jacksonville traffic. The use of Convair 880 equipment should enable Northeast to carry "twice as much traffic as Eastern" along the Boston-Miami route, he said.

FIRST THREE Sikorsky S-61Ls for Los Angeles Airways are on the ramp at the Sikorsky plant. Certification and delivery are expected this summer. Forward part of the passenger cabin can be converted to cargo space.

Los Angeles Airways Expands With S-61s

By William H. Gregory

Los Angeles—Delivery this summer of large turbine-powered helicopters capable of carrying substantial payloads of mail and passengers at the same time will produce a fundamental change in the character of Los Angeles Airways.

Until now, carriage of mail required under the airline's subsidy provision has gotten first priority and has prevented full exploitation of the potential passenger business in this multi-urban industrial and tourist region.

Integration of five Sikorsky S-61Ls —three this year and two next—into the airline's system will bring other changes in addition to the increasing stress on passenger business.

- **Increased frequencies** because of the higher speeds of the new aircraft.
- **Pressure for longer routes.** Los Angeles Airways already has filed with the Civil Aeronautics Board for extensions as far as Santa Barbara and Edwards AFB to the north, San Diego to the south and Lake Arrowhead to the east. Other desert and mountain resorts are a future possibility.
- **Revised fare structure.** Fares now do not relate proportionately to mileage and tend to penalize the longer hauls.
- **Modified maintenance procedures** and increased number of maintenance personnel.

The airline has projected carrying a half-million passengers annually by 1963 compared with the 40,000 level of last year, but Robert Hubley, vice president-traffic and sales, believes that with proper promotion this traffic figure might well be doubled.

By way of comparison, the airline carried 5,362,661 lb. of mail and 2,898,000 lb. of air express in 1960.

One big advantage the helicopter carrier has is the existence of 20 heliports in the Los Angeles area now and the receptiveness of local governments to provide new ones. A city center heliport now is under consideration in downtown Los Angeles and S-61 passenger service might be possible to the downtown area this year.

Present routes of Los Angeles Airways are divided into four segments for schedule making and utilization purposes. Segments A and C (see map) are the shorter run routes to Lockheed Air Terminal on the north and Anaheim-Disneyland to the south. Segment B is the run to San Bernardino to the east, and about twice the distance of the other two. Shuttle service to the Los Angeles main post office downtown is classed as Segment S.

Biggest handicap now to exploiting passenger service is the payload limitation of the S-55, five of which make up the current Los Angeles Airways fleet, and the mail priority. An S-55 may go out full of mail, but the post office may have nothing coming back. Lack of interconnecting traffic and uncertain capacity thus hampers development of a passenger market. Even in all-passenger configuration, the S-55 will carry only 6-7.

Los Angeles Airways' S-61s will be fitted with a 50-cu.-ft. removable baggage pod forward on the left side of the fuselage and two bins aft of the rear door on the right side with a total of 57-cu.-ft. capacity, for a 1,200-lb. total. All double seats on the left forward of the cargo door can be folded to the wall and screened from the passengers aft by a removable partition for added cargo space.

With this flexible passenger-cargo configuration, the airline will go into two new phases of operation. One is the initiation of downtown Los Angeles passenger service. The other will be attempts to break out of the airport-to-suburb service for airline passengers and build an intercity service for businessmen or shoppers, a service that has possibilities in the Los Angeles area because of its geographical dispersion and lack of public surface transportation.

S-61 service also will present Los Angeles Airways the opportunity to tap the potential of a heavy tourist market, Catalina Island, because of capacity not needed to serve the airline's established routes.

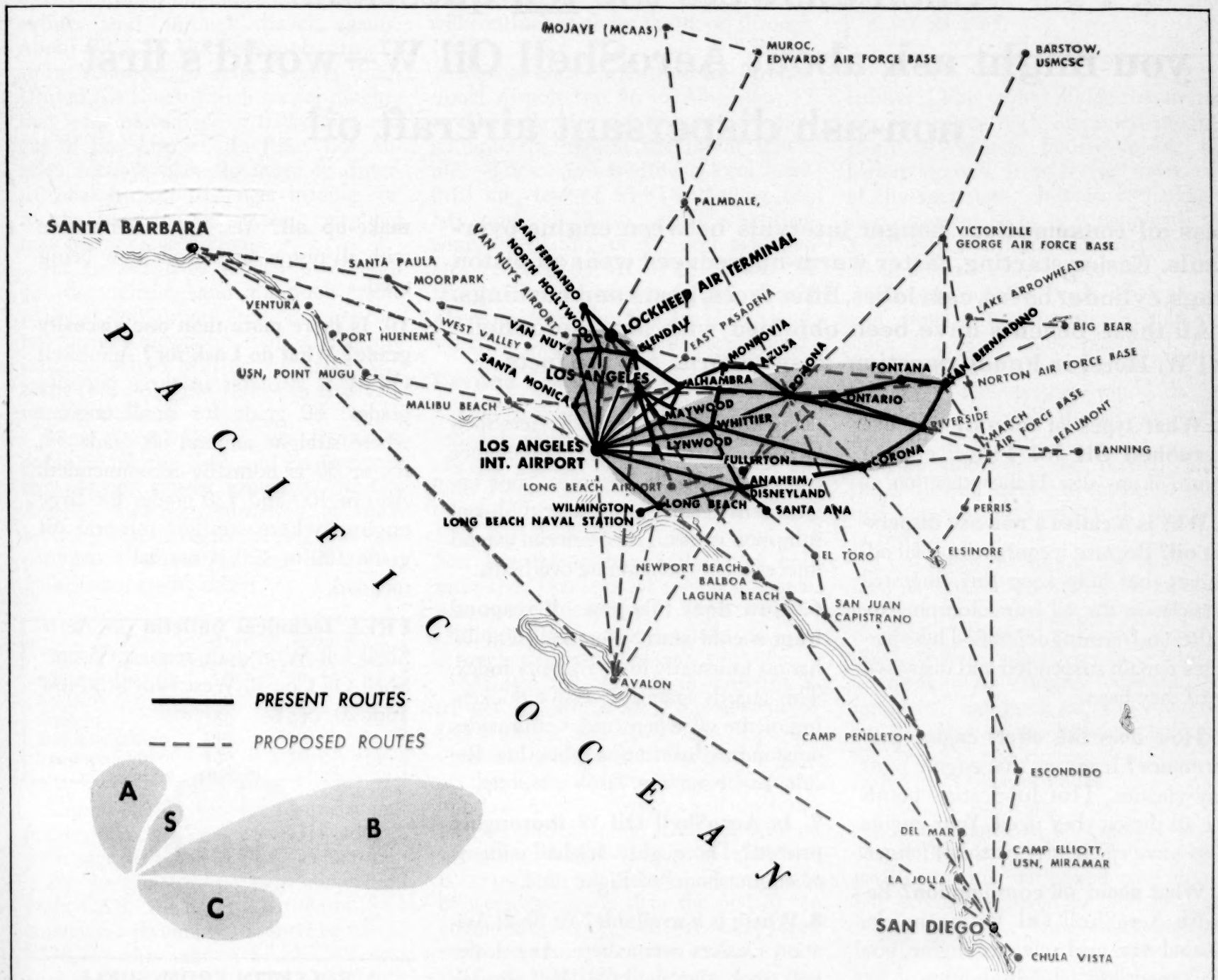
During the summer, the airline plans to make as many runs a day as possible on this 20-min. flight. It also has the potential to serve as a balance for the desert resorts, where traffic would be heavier during the winter.

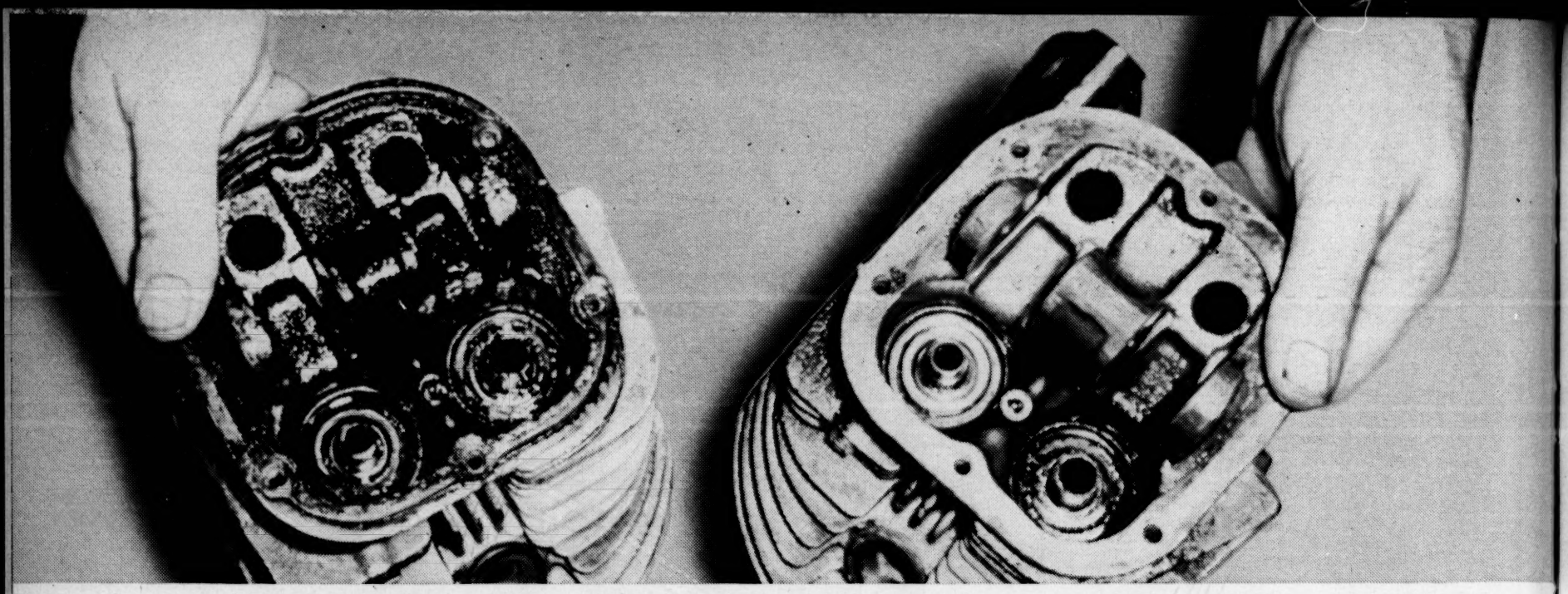
Besides the new services to downtown Los Angeles and Catalina, Los Angeles Airways plans to begin flights to three other new heliports expected to be available:

- **Newport-Balboa.** This would be another tourist market to seaside vacation areas.
- **Pasadena and the west San Fernando** Valley area. Both are growing industrial and residential areas.

San Bernardino, with its ballistic

MAIL IS UNLOADED from Los Angeles Airways S-55 on rooftop heliport at the downtown Los Angeles post office (top). Post office shuttle service is route segment S on map (below) which shows present and proposed route for the carrier. Other route segments are divided A, B and C for scheduling and utilization purposes. Major potential market for the airline is Avalon on Catalina Island, which is shown as a proposed route, but which actually has been declared by CAB as part of the carrier's route area. Other extensions are pending before the Board. San Bernardino, segment B, is the biggest passenger traffic demand point on the system at the present time and Los Angeles Airways believes S-61 capacity and speed can stimulate more traffic.





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BULLETIN:

Shell answers the ten questions you might ask about AeroShell Oil W—world's first non-ash dispersant aircraft oil

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1. What types of aircraft can use AeroShell Oil W? Piston engine planes of any size. Helicopters, too.

2. Why is it called a non-ash dispersant oil? Because it contains special additives that help keep tiny, ingested particles in the oil from clumping together and forming deposits. These particles remain suspended and dispersed until they burn.

3. How does this effect engine performance? It means that engine parts stay cleaner. That lubrication points get all the oil they need. *Your engine runs more efficiently, parts last longer.*

4. What about oil consumption? Because AeroShell Oil W means decreased wear and a cleaner engine, you can expect less oil consumption.

5. Can AeroShell Oil W reduce my maintenance costs? If you have been using a straight mineral oil, AeroShell Oil W can reduce your maintenance costs substantially. Reason: your engine runs cleaner and cooler. Oil consumption is less. Thus, you can extend intervals between engine overhauls.

6. How does this new oil respond from a cold start? AeroShell Oil W has an unusually high viscosity index. This guards against excessive thickening of the oil when cold, yet provides outstanding lubrication when hot. Result: *easier starting, faster warm-up.*

7. Is AeroShell Oil W thoroughly proved? Thoroughly. It's had millions of engine hours of flight time.

8. Where is it available? At Shell Aviation Dealers everywhere. *Any* dealer will stock AeroShell Oil W if you ask for it.

9. Can I add AeroShell Oil W as a make-up oil? Yes. It is compatible with all piston engine oils now being used.

10. Is there more than one viscosity grade? What do I ask for? AeroShell Oil W is available in *three* viscosity grades: 80 grade for small engines where straight mineral oil grade 55, 65, or 80 is normally recommended. Also in 100 and 120 grades for large engines where straight mineral oil grade 100 or 120 is normally recommended.

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missile logistics center, now is the major passenger traffic generation point, and larger capacity and more frequencies provided by the S-61 are expected to enhance this segment.

Importance of military and defense industry traffic to the airline is apparent in that its application for route extensions included:

- **San Diego** to the south and its nearby military bases including Camp Pendleton and the Miramar Naval Air Station.
- **Pt. Mugu** naval base to the northwest and Edwards AFB to the north.
- **Norton AFB,** March AFB, and George AFB in the San Bernardino area to the east.

S-55s now get about 9 hr. utilization a day and average 150 passengers a day plus mail on a schedule averaging 96 flights a day on week days. The S-61s will increase capacity approximately 10 times in their first fiscal year of operation and about 20 times in their second. They are expected to carry 1,000 passengers a day in Fiscal 1961 and 2,000 a day in Fiscal 1962 for a 65% load factor.

Besides the usual local advertising, the airline plans to promote passenger service through the long-haul fixed-wing airlines and through travel agents. About 50% of the helicopter carrier's airline connection traffic comes from United Air Lines, which carries roughly that same percentage of traffic into and out of Los Angeles. In June, Los Angeles Airways plans to move its International Airport passenger loading site to the new United satellite terminal now under construction.

Jet aircraft have tended to smooth out the morning and afternoon traffic peaks at the airport from the helicopter carrier's viewpoint, but it feels the Catalina service will be a valuable segment to fill out the valleys in this connecting traffic.

Some knowledge of the frequency potential of the S-61 and its competitive position can be gained by the Los Angeles Airways comparison of times between International Airport and various cities by surface and helicopter, exclusive of traffic delays.

	Time in Minutes		
City	Surface	S-55	S-61
Alhambra	75	17	11
Burbank	70	17	10
Ontario	150	38	25
San Bernardino	180	50	34
San Fernando	100	20	13

Sikorsky has given the airline a projection of operating costs of 12 cents a passenger mile at a 60% load factor.

In its guaranteed loan application with CAB, the airline estimates S-61 passenger revenues to increase from $278,764 this year to $1,527,759 next year and $2,265,284 the following year. By 1965, the airline estimates passenger revenue to reach $2,916,516 and total revenue $3,436,538.

Flying operation expenses are estimated at $271,561 this year, rising to $715,840 next year, hitting a peak in 1964 of $901,521 and dropping off slightly afterward. Direct maintenance, estimated at $243,482 this year, will rise to $652,000 next and level off in the $700,000-750,000 area for the rest of the period.

Total operating expenses will exceed total revenues through 1964, the airline estimates, but will fall to $3,393,692 in 1965, about $40,000 less than total estimated revenues. It is evident Los Angeles Airways does not expect to reach subsidy-free operation with the first generation of turbine-powered helicopters. The gap will be narrowing, however.

The airline is seeking a guarantee for a $2,891,637 loan from the Bank of America for four of the five ships, whose total cost is $3,212,930. The remainder and the fifth ship will be financed out of cash flow, largely from depreciation and amortization.

Flight equipment depreciation on the S-61s will rise from an estimated $193,699 this year to $403,473 next year and will continue at about that level through 1965.

Typical fares currently from International Airport run $6 to Alhambra, $7 to Disneyland, and $8 to San Bernardino, the highest fare in the schedule. These are based on a local zone, 0-10 mi., fare of $3.85 including tax; city zone, 10-20 mi., of $6; suburban zone, 20-40 mi., of $7, and extended area zone, 40-65 mi. of $8. Thus the fare to San Bernardino of $8 is only $1 more than the fare to Disneyland, which is only about half the distance.

Revised Schedule

The airline is preparing a revised schedule calling for a basic $4 handling charge, plus a dollar for each 10 mi. The 10-mi. local zone fare would be $5 under this schedule, the Disneyland fare the same as it is now, and the San Bernardino fare $10. Not only must the CAB approve such a schedule, but so also must the California Public Utilities Commission, which may be a tougher body to convince.

Maintenance procedures with the S-61 will be similar to those now in effect with the S-62 (AW Apr. 3, p. 40). General Electric will perform engine overhaul at its Ontario, Calif., plant, but Los Angeles Airways will do transmission and airframe overhaul and inspections. Added operations experience is expected to provide longer time between overhauls than the 600 hr. on engine and 300 hr. on gear boxes now applicable for air carrier service.

Under consideration is a progressive overhaul system now used by fixed-wing airlines. This would divide the aircraft into 10 zones, each inspected progressively at various hourly levels, the higher stressed areas at the lower end of the spectrum. Instead of having a ship down for 18 hr. as is done with the S-55, only 6 hr. would be required for an individual zone inspection.

Though not the most efficient system from a maintenance standpoint, since it requires more personnel, it is efficient from the aspect of aircraft utilization. The system would be so established that all aircraft would be flying at peak periods.

More pilots will be needed, since the S-61 will require a copilot, a practice not now necessary with the S-55 or S-62.

Looking to the future, the airline has filed an application with CAB to begin local service in the San Francisco area. A certain element of family rivalry is involved here, since Mervin F. Bagan, a former Los Angeles Airways vice president, has gone to San Francisco and is obtaining on lease-purchase two Sikorsky S-62s to begin a San Francisco Airport to Oakland service.

Intercity helicopter service—Los Angeles-San Francisco, for example—is not out of the question now as being competitive in time with fixed-wing service, but economics, even of the S-61, are not competitive. The competitive limit for the near term future—economically and in time—is about 100 mi., Los Angeles Airways believes.

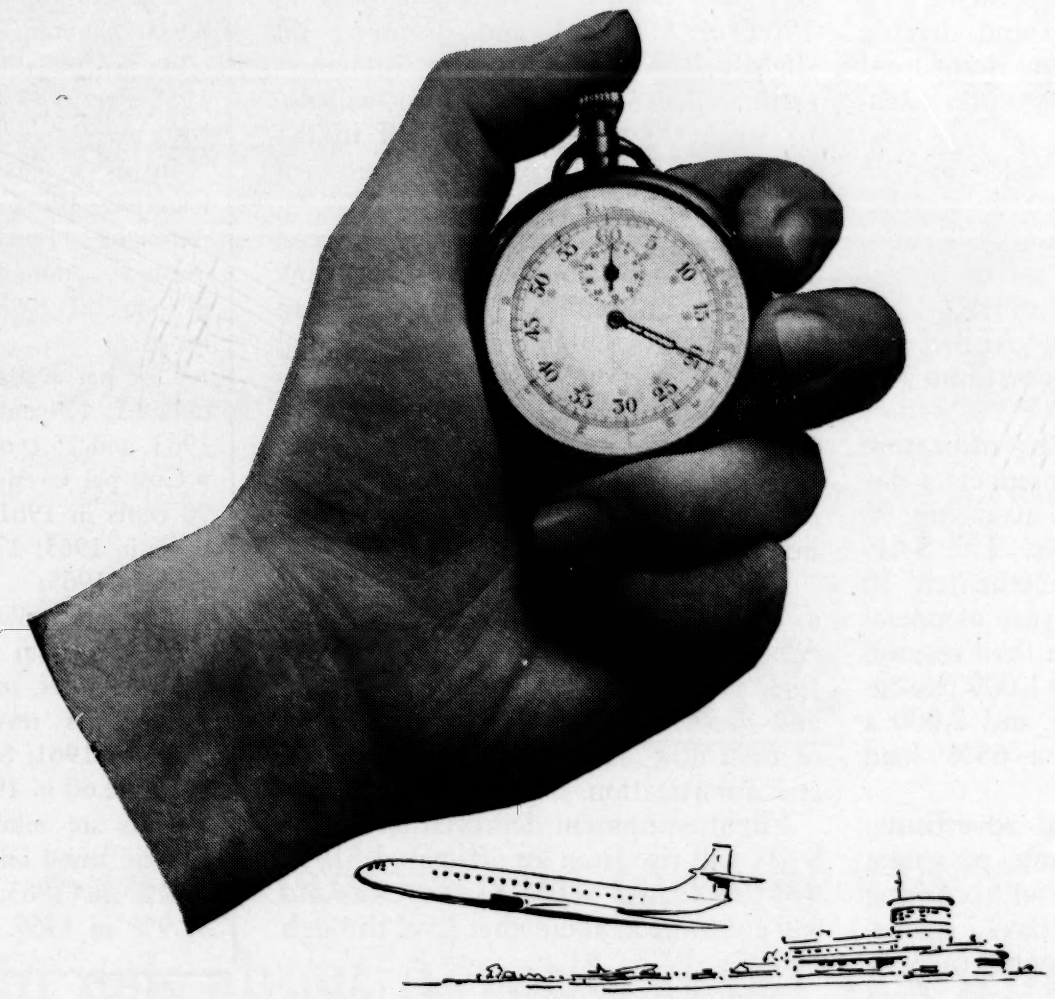
S-61 Operating Cost Estimates

Los Angeles Airways estimates its S-61L operating costs will level off at 13 cents per available seat mile in 1964 and 1965 after S-55 phase-out and transition costs are out of the way.

In its application for a guaranteed loan now being processed by the Civil Aeronautics Board, the airline provides a five-year summary. The first two years include the S-55 phase-out. The estimates:

- Cost per available seat mile: 27 cents in 1961; 17 cents in 1962; 14 cents in 1963, and 13 cents 1964 and 1965.
- Cost per revenue passenger mile flown: 90 cents in 1961; 42 cents in 1962; 31 cents in 1963; 27 cents in 1964, and 25 cents in 1965.
- Cost per available ton mile: $3.10 in 1961; $1.41 in 1962; $1.18 in 1963; $1.13 in 1964, and $1.11 in 1965.
- Cost per revenue ton mile flown: $6.48 in 1961; $3.74 in 1962; $2.90 in 1963; $2.60 in 1964, and $2.31 in 1965.

Costs are total—direct and indirect—and are based on over-all load factors of 40.6% in 1963; 43.7% in 1964 and 47.9% in 1965.



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CAB Bars Hasty Future Merger Action

By L. L. Doty

Washington—Civil Aeronautics Board decision last week, which gave United Air Lines formal authority to acquire Capital Airlines only seven months after the merger agreement was filed, has quashed earlier hopes that future large-scale merger proposals would be handled with equal speed.

Throughout the 60-page opinion, the Board broadly hinted that it viewed the course it was forced to follow in approving the merger with disfavor but stressed that it saw no practicable alternative to saving Capital from its fiscal plight. It said: "Notwithstanding the manifest implications of the merger in terms of maintaining a balanced route structure, we find that the public interest in preventing a collapse of the Capital system outweighs whatever disadvantages may inhere in the merger."

In separate concurrences, two of the four participating Board members, Chairman Alan S. Boyd and G. Joseph Minetti, emphasized they would have preferred broader studies of Capital's problems as an alternative to merger and added that they were not happy with the domestic trunkline route structure as it will exist when the consolidation is consummated. Fifth and newest Board member, Robert Murphy, did not take part in the case.

Boyd said the Board should have studied the possibilities of suspending or transfering Capital's routes at the time the merger agreement was filed. He added that such action is not possible now because of Capital's precarious financial condition.

Minetti, in a dissent filed with his separate concurrence, felt otherwise. He stated that steps could still be taken to keep Capital alive while an investigation of the effects the merger would have on the industry was being conducted. Minetti also doubted that United would reject the merger were the Board to remove the New York-Atlanta-New Orleans route from the merged system. Both Delta and Eastern have claimed that United competition on this route would result in damage to the two carriers. Minetti added:

"In plain terms, the merger agreement with Capital is a once-in-a-lifetime opportunity for United. Common sense dictates that the carrier would adhere to the merger, even if a small portion of the anticipated gain from the transaction were denied it." United, in submitting the merger proposal to the Board, stated that it would drop the merger plans unless all of Capital's routes were transferred to the merged company.

Generally, the Board agreed to this condition in its final decision. However, to protect Mohawk and Allegheny it placed these restrictions on the new route structure:

- **United will be prohibited** from providing service between Harrisburg, Pa., and New York and between Harrisburg and Pittsburgh.
- **No service will be provided** between Philadelphia and Pittsburgh except on flights originating or terminating at Omaha or points west.
- **Single-plane service** between Buffalo and Detroit by United will be prohibited.

General tone of the majority opinion was that the Capital-United merger agreement was a unique case and that the Board was not establishing a new policy by expediting and approving the agreement. It stressed that its opinion was based in large part upon the need for preventing the financial collapse of Capital to protect the financial integrity of the airline industry.

It warned that the "unrestricted approval of this proposed merger agreement does not preclude the Board . . . from taking a second look at the matter in the future in the event that circumstances develop with respect to these routes which we cannot forsee."

It is now apparent that the Board does not anticipate similar emergency problems and that in any future cases strong consideration will be given to such factors as over-all route structure, traffic flow, competition and capacity. In its decision, the Board said the United-Capital merger approval will not prejudge future merger applications, each merger will be decided on its own merits, no new precedents have been established and that past precedents in merger cases do not preclude approval of the United-Capital merger.

In approving the merger, the Board laid down a number of labor protective provisions similar to those applied in previous merger cases. These provisions are designed primarily to ensure fair integration of seniority lists of both companies, to guarantee that no employe will be placed "in a worse position with respect to compensation" as a result of the merger and to provide for equitable displacement and dismissal allowances.

The Board also attached these two conditions to the merger approval:

- **For rate-making purposes,** merger approval shall not be relied upon by United as a basis for augmenting the investment value of assets acquired or as a basis for claiming an investment value in excess of the price paid for assets acquired.
- **In accounting for the merger** transaction, assets and liabilities shall be transferred to United at the values shown on the books of Capital, with any differences between book value and purchase price to be entered in the acquisition adjustment account and held in suspension until all adjustments have been made for items not directly a part of the acquisition adjustment account.

Late last week, United said it agrees to the conditions laid down by the Board and that immediate steps will be taken to consolidate the two companies. The airline expects to complete the merger process by July 1.

Here are the next major steps that must be taken before the merger project is completed:

- **Petitions for reconsideration** must be filed within the next 20 days. Answers to such petitions must be filed within the following 10 days.
- **Board will then give** its decision on the reconsideration petitions.
- **Carriers protesting** the merger decision may seek a court review of the decision, but this action must be taken within 60 days of the date of the Board's decision, which was Apr. 3.
- **United must file** formal acceptance of the conditions attached to the approval of the merger.
- **Merger will be legally** final when United files the merger agreement with the Secretary of State of Delaware, the state in which the carrier is incorporated.

American Profit Drops As Revenues Increase

Washington—American Airlines last week reported net earnings of $11.7 million for 1960, a 44% decrease from 1959 profits despite a 13.4% increase in revenues.

Expenses for the year totaled $408 million, a 16% increase over gross expenses in 1959. Net working capital for the year was $57.7 million, compared with $72.3 million the previous year. In its annual report, American gave these reasons for the decline:

- **Growth in traffic** during the year was less than usual because of a slowing down in the economy and a sharp squeeze on business profits generally.
- **Costs for the transportation** of mail and airfreight increased, but there was no increase in charges for such transportation.
- **Trend toward lower-priced** aircoach service depressed gross revenues.
- **Basic costs have continued** to increase, offsetting in part economies expected from the use of larger and more efficient aircraft.

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Supplementals Pressing to Expand Transatlantic Charter Business

By Robert H. Cook

Washington – Supplemental airlines are hoping the Kennedy Administration's efforts to attract more foreign travelers to this country will open the way for the carriers to move into transatlantic charters on a large scale.

Independent Airlines Assn. is expected to concentrate on the need to offer lower air fares to Europeans to "break the price barrier" on international travel and to aid in the Administration's campaign to improve the U.S. foreign payments balance when the supplemental carrier group testifies in a House Commerce committee hearing on establishment of an Office of International Travel.

IAA will argue that while the transatlantic charter business was almost evenly divided between American flag, foreign and supplemental carriers in 1959, the foreign airlines more than doubled their share of this market last year by offering new, low-cost charters.

Capitol Airways and California-Hawaiian Airlines, supplemental airlines and members of IAA, last month asked Civil Aeronautics Board permission to inaugurate reduced charter fares over the Atlantic this summer at rates some of which are less than half the current economy-class fares.

Filing of the new tariffs, scheduled to be effective Apr. 16 for Capitol and Apr. 26 for California-Hawaiian unless rejected by the CAB, has raised a difficult question for Board attorneys because of the airlines' contention that their fares are permissible under Section 401(F) of the Federal Aviation Act. This section, similar in meaning to sections of the Interstate Commerce Act applied to bus charter operations, permits CAB to grant any certificate airline an exemption to conduct "special service" type charters subject to its prescribed economic regulations.

Section 207 of the Board's regulations spells out the ground rules for granting charter and other "special service" operations for trunk carriers but makes no distinct reference to supplemental airlines. It is primarily on this point that the supplementals contend their tariffs should be permitted, since there appears to be nothing in the Board's regulations to specifically detail the charter control over their operations.

CAB spokesmen admit that Section 207 does not contain any specific reference to charter rules for the supplementals and indicate the obvious solution to this omission may require a further amendment to the section to include the supplemental carriers.

While IAA and the two supplementals will push hard for the lower air fares on the basis of the "public interest" angle that the over-all savings will produce a greater volume of foreign visitors to this country, it is doubtful that CAB will permit the fares because of the powerful competitive effect they would have on U.S. flag carriers.

IAA notes that should the Board vote to reject the tariffs, or suspend them for further investigation, the association will demand a full public hearing on charter fare problems. CAB's cooperation with the International Air Transport Assn. agreements setting international fare levels constitutes "an Iron Curtain against lowering fares across the Atlantic," IAA officials charge.

Capitol's plan is aimed primarily at Europeans and would offer piston-engine, round-trip transportation between major European cities and New York at a price of $195 from London, $295 from Rome and $245 from Frankfurt. Summer economy fares for round-trip, piston-engine transportation between the same cities under the existing IATA agreement are London, $450; Rome, $584, and Frankfurt, $525.

California-Hawaiian's proposal is similar in that it will tailor its flights to the volume of business generated. The airline expects to provide a minimum service of two flights a week, providing a pattern of 14- and 20-day circle tours from Europe to the larger U.S. cities.

Low Transatlantic Fare

Flying Tiger Line will introduce a transatlantic charter rate June 1 that will permit Europeans to fly to the U.S. East Coast for round-trip fares as low as $99.

The low rate, based on an aircraft charter rate of $11,682, applies only to groups originating in Europe. The rate of $260 per passenger will apply on charter trips originating in the U.S. Lockheed 1049H Constellations with 118 seats will be used on all Flying Tiger charters.

Purpose of the east-west low charter rate is to attract European groups as a means of offsetting seasonal imbalance of U.S. charter flights. Because of this seasonal difference, the carrier operator in the past has been required to deadhead aircraft and crews on the return leg of U.S. charters.

Competitors Oppose Cargo Merger

Washington—Competing U.S. airlines are raising strong objections to the proposed merger between Riddle Airlines and Aerovias Sud Americana, and Pan American World Airways is charging that the two cargo carriers are contriving an unofficial merger in advance of Civil Aeronautics Board approval.

Riddle Airlines last month asked Civil Aeronautics Board to permit a merger with Aerovias Sud Americana, an international cargo carrier, that would extend Riddle's all-cargo domestic routes into Latin America.

Pending the Board's decision on the merger, Riddle has entered into a series of agreements with Aerovias. A trip lease and interchange agreement is now before the Board for approval, accompanied by a request for exemption from hearing until after the decision on the proposed merger. Sales, maintenance, service agreements await Board approval.

The trip lease pact would allow Riddle to rent Aerovias aircraft by the hour, with Riddle crews operating them over Riddle routes. Aerovias would provide maintenance and hull insurance, and both airlines would take out liability and property damage insurance.

The interchange agreement would allow Riddle's aircraft to operate through services on both routes, with the transports controlled and operated by the carrier over whose routes they are being flown. Riddle is to be responsible for maintenance and hull insurance, and both airlines will take out liability and property damage insurance.

Pan American charges that the merger would give Riddle unfair advantage by eliminating trans-shipment and would effect a "major realignment" in the Latin American route pattern. The carrier also says it has been seeking CAB permission for 12 yr. for route entry into the U.S. but had failed.

Pan American filed an additional protest against the five Riddle-Aerovias economic agreements, charging that Riddle intended to implement them without CAB approval. The five agreements, Pan American says, constitute a "de facto" merger that prejudices the Board's decision and, if the formal merger proposal is denied, will leave the two companies so entwined that it would be hard to unscramble them.

National Airlines, Trans Caribbean Airways, Delta Air Lines and Braniff Airways joined Pan American's protests against the merger. All notified the Board that if merger is approved they would seek similar route advantages.

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Take the huge Ballistic Missile Early Warning System that RCA is building for the Defense Department. Since the project is near Fairbanks, Alaska, close communications with company headquarters posed a problem.

The solution was found when RCA contracted **Alaska Airlines** to operate a once-weekly round-trip flight service between Philadelphia and Fairbanks. Flights involve 6,866 round-trip miles per week . . . a total of over 300,000 miles for the year. Cargo includes both men and materials.

Air freight expands to include direct ground link. Local service airlines make it possible to fly freight into practically any city in the U.S. Last year, local carriers moved over 5 million tons of air freight—a 200% increase over 1950.

Now, shippers in the Arkansas-Louisiana-Texas area can take advantage of a new convenience offered by **Trans-Texas Airways.** On May 1, the Railway Express Agency began door-to-door pickup and delivery for Trans-Texas—a direct ground link for their air freight traffic.

Local carrier "watch dog" service protects nation's timber stands. Stranded vessels have been saved. Strayed livestock recovered. Fishermen rescued. Power line breaks discovered. All because of the vigilance of local carrier flight crews. But perhaps the most valuable "watch dog" service these men perform is detecting and reporting forest fires.

Pacific Air Lines flights, for instance, cover 26 national forests as well as many of the nation's most valuable stands of timber. Last year, Pacific flight crews alerted state and national forest firemen to fires in many areas—thus helping prevent the loss of millions of dollars worth of standing timber.

Local carriers offer exciting vacation tips for the time- and budget-conscious. Because they cover the entire United States, local service airlines offer almost unlimited vacation possibilities. Skiing, skin-diving, sight-seeing, bull-fight attending—to name just a few. Vacation planners find local carrier facilities especially helpful in planning short or inexpensive vacations. **Bonanza Airlines** flies vacationers to all the scenic wonders and famous winter resorts of the Southwest—including fabulous Las Vegas. **Trans-Texas Airlines** schedules week-end flights at special rates to the colorful old cities of Laredo and Nuevo Laredo. Or, for something different, travelers can get a breathtaking view of the Hawaiian Islands from **Aloha Airlines** sightseeing planes. Special lens windows let shutterbugs take undistorted shots of nature's grandeur below.

Central Airlines offers perhaps the **shortest** vacation on record. As part of its regular service, it schedules 20-minute, Sunday afternoon "Scenic Flights" over the 36 cities in its area. The cost? Just $2.50.

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SHORTLINES

▶ **Aeroflot,** the Russian airline, has signed an agreement with United Air Lines providing single ticket service for passengers and cargo over the routes of both airlines. Connections to Moscow on Aeroflot's 150,000-mi. route system are made at London, Paris, Copenhagen, Brussels and Amsterdam.

▶ **Allegheny Airlines** reports 133,000 passengers have flown a total of 38.2 million mi. on its commuter flights in the last 18 months. Commuter flights are operated at first-class fare with provision for inflight ticketing, simplified baggage handling and 40% discount for no-reservation passengers.

▶ **Lineas Aereas TACA de Colombia** (TACA) and Cinta Limitada (CINTA) of Chile have had their foreign air carrier permits canceled by Civil Aeronautics Board. The carriers, authorized to operate between points in their respective countries, the Caribbean and Miami, had not operated into the U. S. for several years.

▶ **Lufthansa** will buy out Condor Luftreederei of Hamburg, a local airline, in November. Condor's two Convair 440s will be used to supplement Lufthansa and its subsidiary, Deutscher Flugdienst.

▶ **Pan American World Airways** reports the use of portable cargo containers fitted in place of unoccupied seats on turbojet transports. The containers weigh 122 lb., are collapsible and have a 48-cu.-ft. capacity. While Pan American normally uses up to four, as many as twelve can be used to increase cargo capacity by three tons.

▶ **Philippine Air Lines** has been recommended by a CAB examiner for a U. S. foreign air carrier permit authorizing service between Manila and San Francisco, Calif., via Honolulu. Request for a Tokyo stop on the route was rejected.

▶ **Tasman Empire Airways, Ltd.** of New Zealand has received temporary U. S. certification to operate between New Zealand, Fiji, American Samoa, Cook Islands and the terminal point, Tahiti, Society Islands, until June 30.

▶ **Trans-Texas Airways** began Convair service between Houston and Dallas, Tex. and between Lake Charles, La. and Dallas Apr. 1 with the first three of 22 Convair 240's bought from American Airlines. Two more will be delivered this month and will be operated between Dallas and Little Rock, Hot Springs and Texarkana, Ark.

AIRLINE OBSERVER

▶ Boeing's cargo version of the 707-320B series turbofan-powered transport, which would carry an 82,000-lb. payload, is attracting serious airline interest, especially from Pan American and TWA. Major attraction is the promise of delivery in 1962. The airplane would be side-loaded, with cargo doors aft and forward of the wing, have a strengthened wing spar and heavier gage fuselage skin. Price of approximately $6 million—against $9 million for a swingtail version of the aircraft—has airlines now asking: "Is there anything fundamentally wrong with side loading?" These carriers feel that proper ground-handling equipment could make side loading as efficient as the swing-tail system.

▶ **Watch for the Assn. of American Airport Executives, at its Apr. 20 convention, to refuse responsibility for measuring slush accumulation on runways. Federal Aviation Agency has proposed a rule which would limit the takeoff gross weight of turbine-powered aircraft when slush stands more than 0.5-in. deep. However, AAAE and the Air Transport Assn. prefer that FAA do the measuring.**

▶ Federal Aviation Agency may expand its research program on turbojet flight crew fatigue on the basis of initial medical findings made last year on a test group of flight engineers. FAA wants to include pilots and hostesses in a new study and is concerned that a progression of physical problems discovered among engineers who transferred from piston to turbojet aircraft duties may be directly related to the number of monthly duty hours permitted flight crews on the faster equipment.

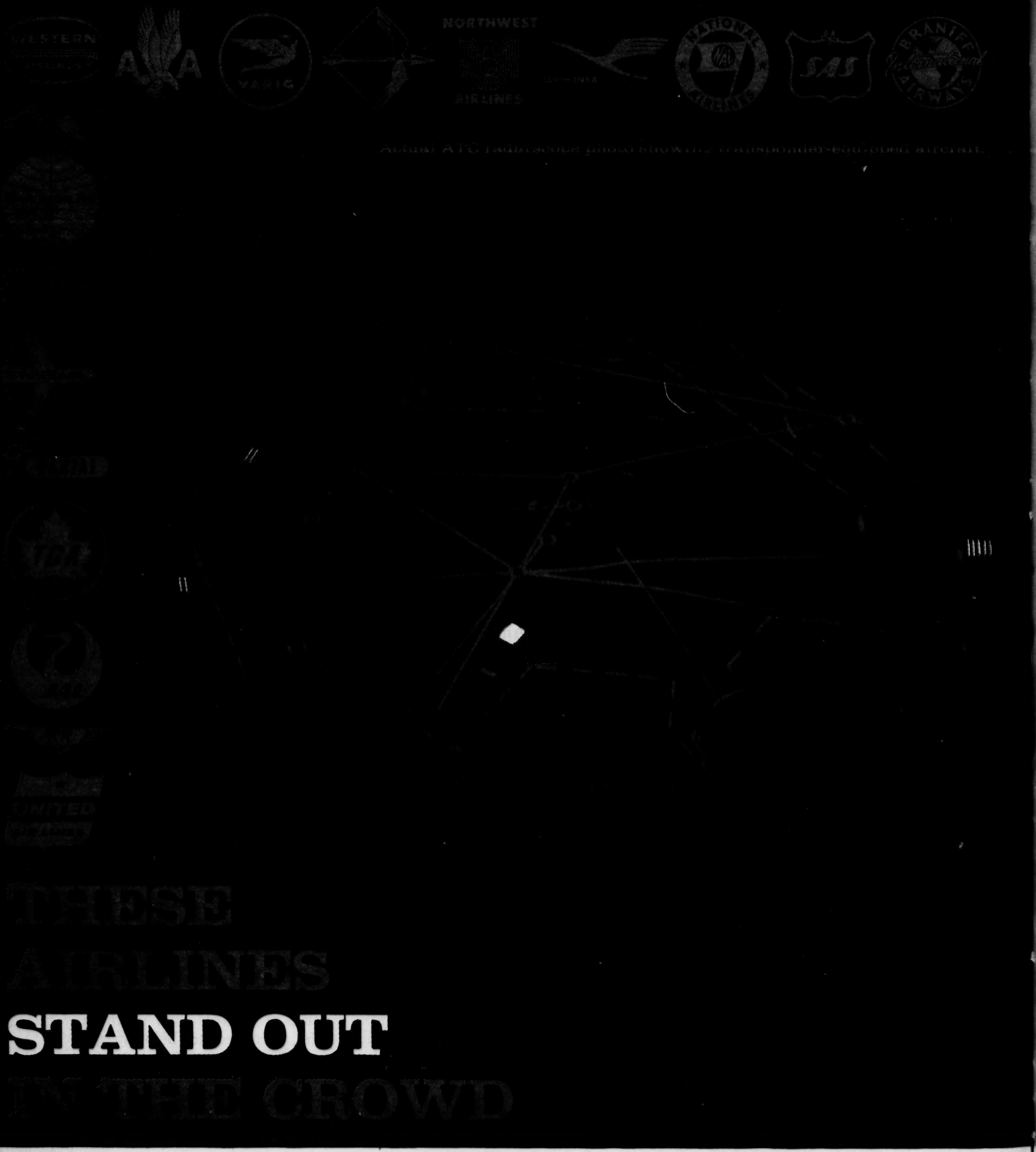
▶ **Cunard Eagle Airways plans to buy two Boeing 707-420 turbojet transports if its pending request for scheduled London-New York service is approved by the British Air Licensing Board. Although such flights would be directly competitive with British Overseas Airways Corp., Cunard officials are confident the application will be approved within the near future. Delivery dates for the 707-420 have been set for 1962, as opposed to the 1964 schedule proposed by British Aircraft Corp. for the VC-10 bypass-engine transport, which Cunard has been urged to buy for use on its proposed transatlantic route.**

▶ British Aircraft Corp. has dropped plans to produce its proposed VC-11 medium-range jet in view of the success Boeing has had in selling its 727 transport. BAC will concentrate its efforts on a new version of the short-medium-range Hunting 107, to be designated the BAC 111. The 111 will be powered with two Rolls-Royce Spey bypass engines producing 9,450 lb. thrust each. BAC will also continue to push its long-range VC-10 bypass engine transport.

▶ **Convair is offering Swissair the use of two Convair 880M-22 medium-range jet transports on a lease basis to serve the airline's route to Tokyo during the peak summer traffic season because of delivery date postponements for the longer-range 990. Lease offer, designed to help Swissair match jet competition on the route until arrival of the 990 late this year, was one of several suggestions made by Convair during a recent visit of top Swissair personnel to San Diego to discuss the delays. An airline spokesman said last week that a decision whether to accept the offer should be made by mid-April.**

▶ Federal Aviation Agency will conduct an industry-government conference June 6 on requirements for proficiency flight maneuvers. Purpose of the conference is to determine whether proficiency flight maneuver requirements for turbojet aircraft should be considered separately from those for piston engine aircraft.

▶ **Specially designed maintenance recorder will be installed by FAA in either a Boeing 707 or Convair 880 turbojet transport in an effort to determine what areas wear out first on airframes and engines. Device will collect and store data on effect of turbine inlet temperature, gyroscopic loads imposed during turns, wing movement in taxi operation and other subtle forces that affect safe life of an aircraft.**



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Bermuda Fosters Midwest Tourist Market

By Glenn Garrison

Hamilton – Tourist-supported island of Bermuda is feeling the impact of the jet transport, which travel people here regard as something of a mixed blessing.

Jet service has brought Bermuda less than two hours from New York. But the jet also has cut times to other resorts in the Caribbean and Bermuda faces a loss of business to these once remote localities.

As a countermeasure, Bermuda is making a strong effort to tap markets deeper in the United States. Bulk of this island's tourist business for many years has come from the middle Atlantic states and New England. New York, New Jersey and Pennsylvania account for 59% of the traffic, with New England contributing another 22%.

Potential Market

The area now attracting Bermuda's attention is the east north central region which includes Illinois, Indiana, Michigan, Ohio and Wisconsin. This area has provided only 8% of Bermuda's business, but its new accessibility by jet makes it a rich potential market for Bermuda. New airline schedules will offer a 7 a.m. departure from Chicago with arrival in Bermuda at 12:30 p.m. Service is via New York, but the island's trade development board is seeking direct airline flights from Chicago.

The development board recently opened an office in Chicago to promote business in the Midwest.

Reshaping of travel patterns by the time-cutting jet transports has even brought Hawaii and Bermuda into competition for tourist business. During the last half of 1960, Hawaii attracted more travelers from east of the Mississippi than from the western U. S. This was cutting into Bermuda's territory, and the island's new promotional program is partly designed to counter this competition. The development board even sees California as a future market, and for the first time this year is advertising in a California magazine.

90% Load Factor

First jet service between New York and Bermuda was inaugurated in March, 1960, by Pan American and its Boeing 707-320s and Douglas DC-8s operated with 90% load factor that month. PanAm's jets cut into the piston and turboprop competition of Eastern Air Lines, British Overseas Airways Corp. and Eagle Airways of Bermuda. During two off-season months last year, Eastern's load factors on its DC-7B and Lockheed 1049G equipment dipped into the thirties. Eastern put DC-8s on the run for a couple of peak season months but, being presently short of jet equipment, withdrew them. Plans are to re-introduce the jets this month. BOAC last month began daily jet service with 707-420s.

Load factors on Eagle's Viscount and Britannia turboprops held up well last year in the face of jet competition. But Eagle had a unique advantage: it was not a member of International Air Transport Assn. and set its fare lower than the other carriers. Eagle's round-trip rate from New York is $85 tourist, whereas the other airlines charge $105 propeller and $115 jet fares.

However, Eagle joined IATA last December—reportedly under pressure from other carriers and to offset the threat of a fare-cutting war. Its new fare effective next week is $95, and departure times from New York have been moved back from late afternoon to after 9 p.m. This means arrival in Bermuda at a time approaching midnight. Eagle still has a fare advantage over the other carriers, but on Oct. 31 all of the airlines plan to introduce special excursion fares good on certain days of the week through Mar. 16. These fares are $95 jet, $85 propeller.

Operation of the evening flights is more economically suitable to Eagle than it would be to the other carriers because Eagle is Bermuda-based and no crew layovers are required.

The airlines offered 161,186 seats between the U. S. and Bermuda last year. Figure for the first three quarters of the year was 120,332, a total expected to increase to 159,372 this year.

Arriving air passengers last year totaled about 100,000. Another 40,000 visitors to the island arrived by cruise ship and about 12,000 came by regular ship. About 85% of Bermuda's air passengers are from the U. S., about 11% are from Canada and approximately 2% from the United Kingdom.

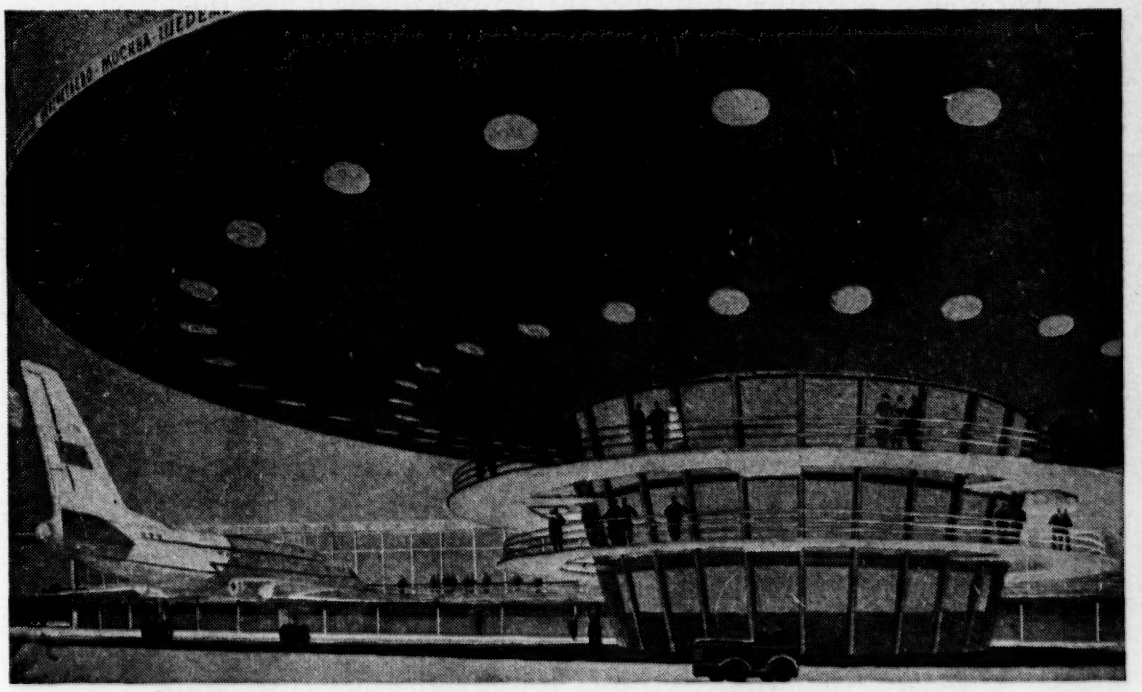
A major difficulty in selling to the midwestern area has been the problem of airline connections. Passengers from such cities as Chicago were usually faced with an overnight layover in New York. But now the jets and rearranged schedules make same-day service possible.

Jets Cause Concern

Some Bermudians view the advent of jets warily. They forsee a possibility that the character of Bermuda's tourist attractions could change drastically if a mass market were to descend on the island.

"We don't subscribe to making Bermuda a suburb of New York," a trade development board official said. The average visitor to Bermuda stays seven or eight days and the possibility of jet-loads of one-day visitors cluttering the island's beaches makes Bermudians shudder.

Recently, Pan American brought two chartered DC-8s to the island where



Sheremetyevo Air Terminal Planned

Artist's conception of new Russian terminal which the Soviets are planning to build at Moscow's Sheremetyevo Airport bears resemblance to Pan American's Idlewild terminal. Present main passenger terminal, in use for less than one year, no longer "meets up to date demands," according to G. Ilkin, chief architect of the Aeroproyekt Design Institute. New terminal will be a two-story building of ferrous concrete. Second floor waiting room will have an area of 32,280 sq. ft. Round building in foreground, although not identified, apparently is the restaurant and visitor's observatory.

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personnel of a New England company spent the day, touring the island and returning home the same night. The same company is thinking of running a similar flight to London.

But despite this possibility raised by Bermuda's closer proximity to the U.S., trade officials do not forsee a tourist traffic explosion such as is taking place in the islands south of Bermuda. Efforts will be made to keep Bermuda much as it is. Hotel beds through last year totaled 4,400; with the completion of a new hotel this summer, the total will be about 5,000. It is not expected to get consideraby higher. The new hotel is the first since 1930, with the exception of one new hotel that replaced another destroyed by fire.

Added Jet Service

Another jet service to Bermuda will begin this month when Guest Aerovias Mexico puts de Havilland Comet 4s on the run between Miami and the island. These airplanes are being provided by CMA Mexicana de Aviacion as part of an equipment consortium arrangement among Mexican carriers.

Canadian traffic to Bermuda and the Caribbean will be offered new lowered fares on Trans-Canada Airlines' new Vickers Vanguard turboprops. Special excursion rates from Montreal/Ottawa/Toronto to Bermuda will cost as little as $99 round-trip economy, compared with $141 economy at present. From the Canadian cities to Barbados, round-trip economy excursion fare will be $199, down from $265.

Airline seats offered between Canada and Bermuda totaled 9,479 for the first nine months of last year; the total this year is expected to be 9,554 for the same period.

Full Passenger Load Carried on Tu-114

Moscow—Aeroflot Tu-114 has made its first proving flight from Moscow to Khabarovsk with a full load of 170 passengers—all officials and employes of the Russian aircraft and airline industries.

The 4,300-mi. trans-Siberian run was made nonstop in slightly over 9 hr. The four-turboprop transport carried two complete crews which relieved each other every 2½ hr.

Soviet officials have again promised to open regular Moscow-Khabarovsk Tu-114 passenger service "shortly." Such operations were first scheduled to begin in 1958. Latest missed target date for scheduled Tu-114 passenger flights was January, 1961 (AW Dec. 26, p. 19). Tu-114s have made frequent Moscow-Khabarovsk proving flights carrying cargo and partial passenger loads.

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United Technology Builds Larger Booster C

By Russell Hawkes

Sunnyvale, Calif.—Main theme in the plans for the future of United Technology Corp. is the development of immense, economical solid propellant space vehicle boosters at the company's $30-million research and development facilities here and at nearby Morgan Hill, Calif.

The installation has grown so quickly and with so little fanfare that many otherwise well-informed industry officials are scarcely aware that it exists. Yet UTC President Lt. Gen. Donald L. Putt, USAF-ret., claims the facilities are the most advanced in the solid rocketry business and are capable of handling the largest motors now proposed.

The UTC staff has been in operation for only two years. During that time UTC has been equipped and operated with money supplied by the parent-company, United Aircraft Corp. As yet, the corporation has had no very large contracts to reward this investment and Gen. Putt concedes that it will be years before the returns equal the cost of the elaborate facilities. However, the sprawling development center near Morgan Hill is just reaching 100% operational status and this is expected to step up the flow of new business.

At present, 80% of the research and engineering effort at UTC is devoted to the development of a family of large conical segmented solid propellant rockets as space boosters. The buyer of such a system could stockpile segments beforehand and assemble them into a booster system optimized for the mission on short notice.

In the future, UTC officials foresee that a large part of the company's capabilities will be used in the development of hybrid (liquid oxidizer and solid fuel) rockets. It is now building its first hybrid rocket and plans to fire it for the first time late this spring.

According to the UTC design philosophy the boosters of space vehicles should be as inexpensive as possible, even at the sacrifice of technical sophistication. This philosophy is based on the assumption that the proper aim of a booster development program should be to make a rocket which will orbit the maximum payload per dollar. The history of rocketry in this country shows that an effort to get maximum sophistication always increases costs much more rapidly than it increases performance figures. In fact, some engineers have estimated that to improve the performance of any design by 5% will increase its cost by 50%. In upper stages, such a ratio can be accepted because payload is very small compared with propulsion system weight and a minor reduction in the latter or a minor improvement in total impulse can increase payload by a respectable percentage.

UTC scientists argue that this is untrue for the boosters because the weight of the upper stages and the payload is large with respect to the weight of the bottom stage. Therefore a minor increase in impulse or decrease in weight of the bottom stage will have a negligible effect on the weight placed in orbit but will have quite a sizable effect on the cost of the system. Sheer size can increase the weight in orbit more economically than sophistication, according to their analysis.

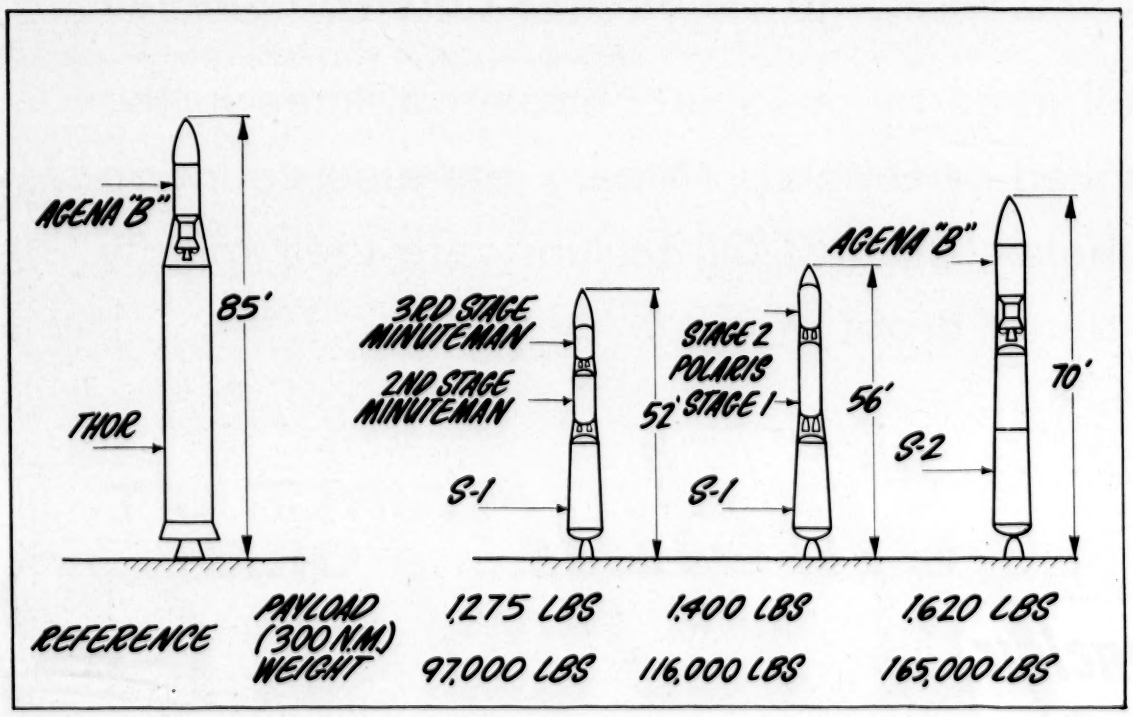
No exotic materials are to be used in the case or nozzle of the UTC conical segmented motor and no ultra-high performance propellants will be utilized. UTC propellant research for the conical segmented motor has been directed mainly toward finding propellants with better physical properties and lower costs which can still approach the specific impulse and density of current workhorse propellants.

In the size range that most interests UTC, the "slump" of propellants under their own weight is a serious problem. In the case of the butadiene propellants, researchers are seeking better tear strength. If all efforts fail and no better physical properties can be created, UTC officials believe segmented rockets can still be built to larger scale than conventional rockets. If a crack or other flaw develops in one segment it cannot propagate past the segment joint and only one segment need be scrapped rather than a whole booster. Conventional steels will be used in the conical segmented cases and insulator and linear materials probably will not be very unusual, though research is being conducted in that field.

Vehicle Cost

About one-half to two-thirds of the cost of a solid propellant launch system is in the vehicle itself and the remainder in ground equipment. Therefore, vehicle optimization pays larger dividends than in liquid propellant booster systems in which ground equipment accounts for the larger part of system cost. Contrary to much of the early thinking on the subject, UTC technologists have concluded that the best place for liquid propellant rockets in space vehicles is in the upper stages, where maximum performance is more rewarding. Their operations analyses indicate that the cost per pound in orbit of a system with liquid propellant upper stages may actually be about two-thirds of the cost for an all-solid launch system. According to their calculations, the lowest cost per pound in orbit for chemical rockets will be between $120 and $200.

The dual purpose of the segmented rocket concept was to allow larger rockets to be transported by moving them in sections and to get minimum costs through the flexibility of a building block concept. The purpose of the UTC conical design is to enable seg-



S-1 AND S-2 SEGMENTS, now company-funded, may be able to play a role in space without awaiting development of larger stages.

r Capabilities

mented rockets to be built to the maximum length, thereby increasing the range of flexibility in application.

The segmented rockets have internal burning grain designs, but unlike most conventional solid propellant rockets the hollow charge ports are circular rather than star-shaped. This is made possible by using variations in the design of the propellant interstices at the segment joints to provide the extra initial burning area usually provided by salients and slots in the star-shaped charge ports.

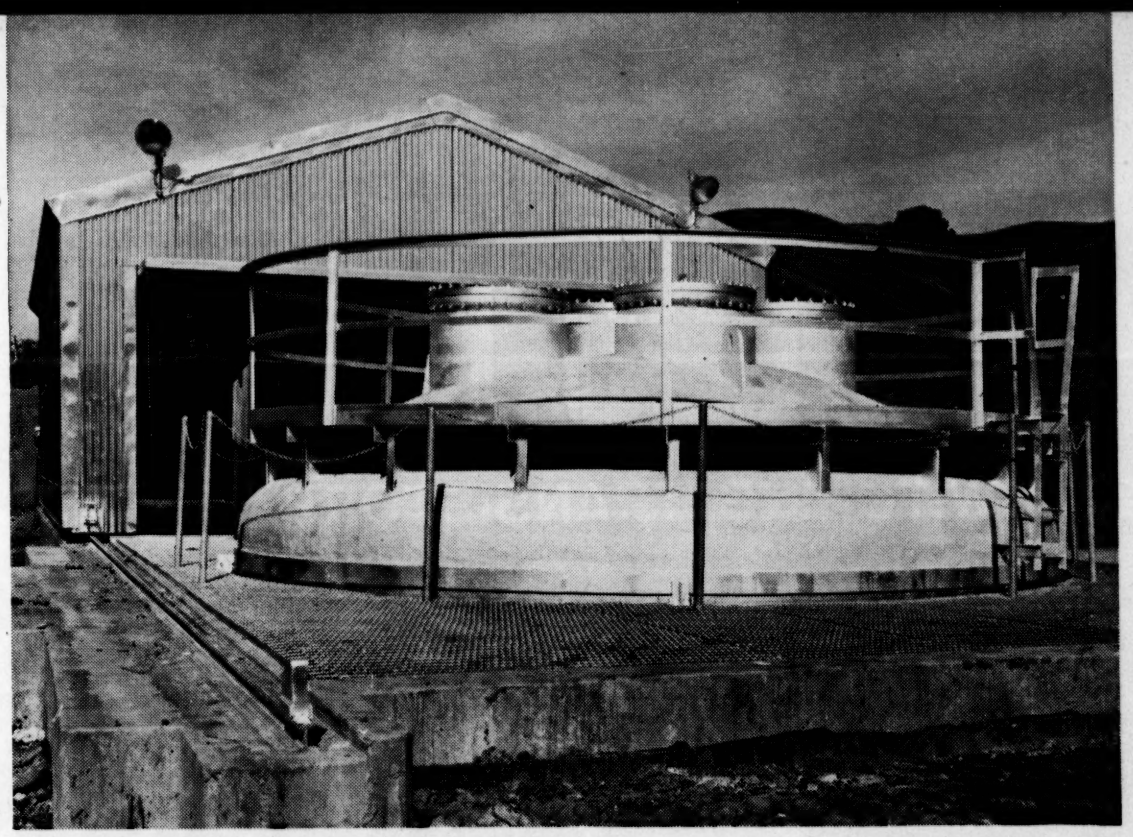
Segment Size Limits

UTC engineers estimate the limit on the length to which cylindrical segmented rockets can be built is set by the fact that as hot gas flows down the charge port toward the nozzle it is constantly accelerated by the addition of more gas from the propellant surface over which it flows. When the gas flow passes Mach 0.4 or Mach 0.5 the result is erosive burning and instability.

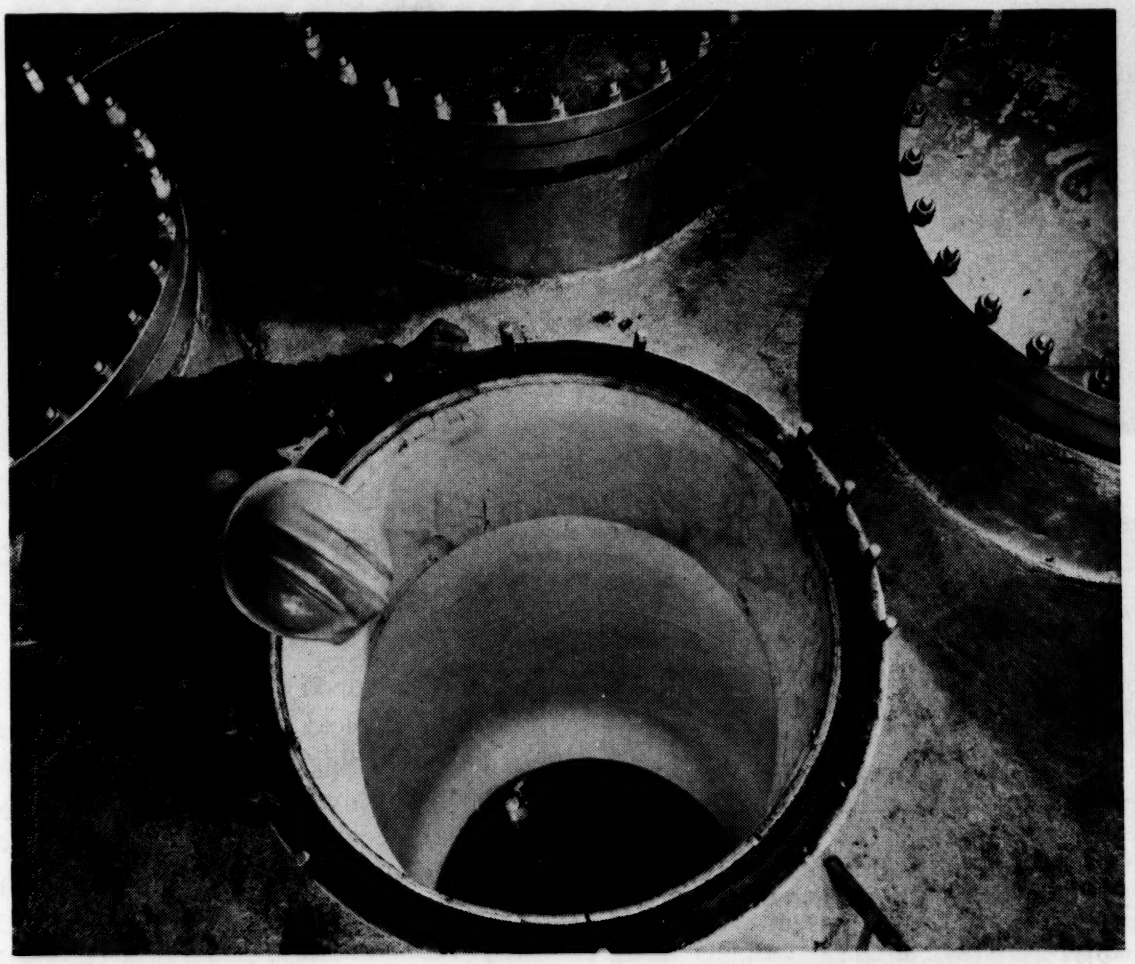
The conical design is intended to avoid erosive burning by increasing the cross-sectional area of the port to accommodate the increased volume of gas as it approaches the nozzle. The UTC engineers estimate this eliminates combustion problems as a limit on size. The next limit is imposed by the natural bending frequency of the rocket.

When added length brings the bending frequency close to the natural frequency of the control system, disastrous instability results. When this limit is reached, the long rockets can be clustered to increase their stiffness. The effect of clustering is to increase the strength so much that the complete system is overdesigned with respect to the stiffness required. This, in turn, enables the designers to lengthen the rockets in the cluster. UTC engineers say cluster fittings add little inert weight to a solid propellant rocket because the 750-psi. chamber pressures are still the heaviest stresses the case must bear and relatively crude cluster fittings can be used to grip the strong, individual cases in the cluster. Another size limit is the estimate by UTC that conical segments become volumetrically inefficient at diameters near 20 ft.

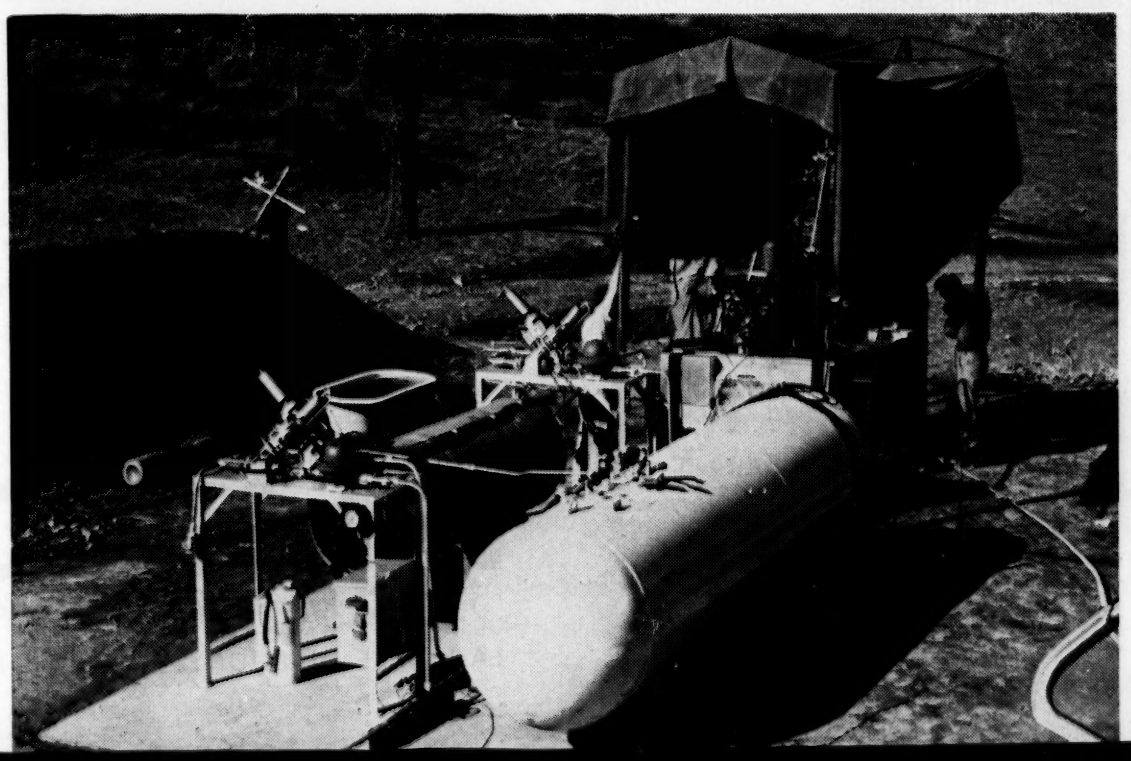
The cone angle of the UTC segmented rocket is much smaller than it appears in drawings and is scarcely visible. The cone angle for present designs is about two degrees. For larger rockets, the angle may prove to be even less and much smaller rockets may have cone angles as large as four degrees. The conical shapes will have



LARGE CASTING and curing oven in UTC development center near Morgan Hill, Calif. The oven has a usable diameter of 20 ft. and a depth of about 50 ft.



IN-GROUND curing oven is viewed from above. Alpha liquid test stand (below) for relatively small motors was first to be put into operation at the UTC development center.



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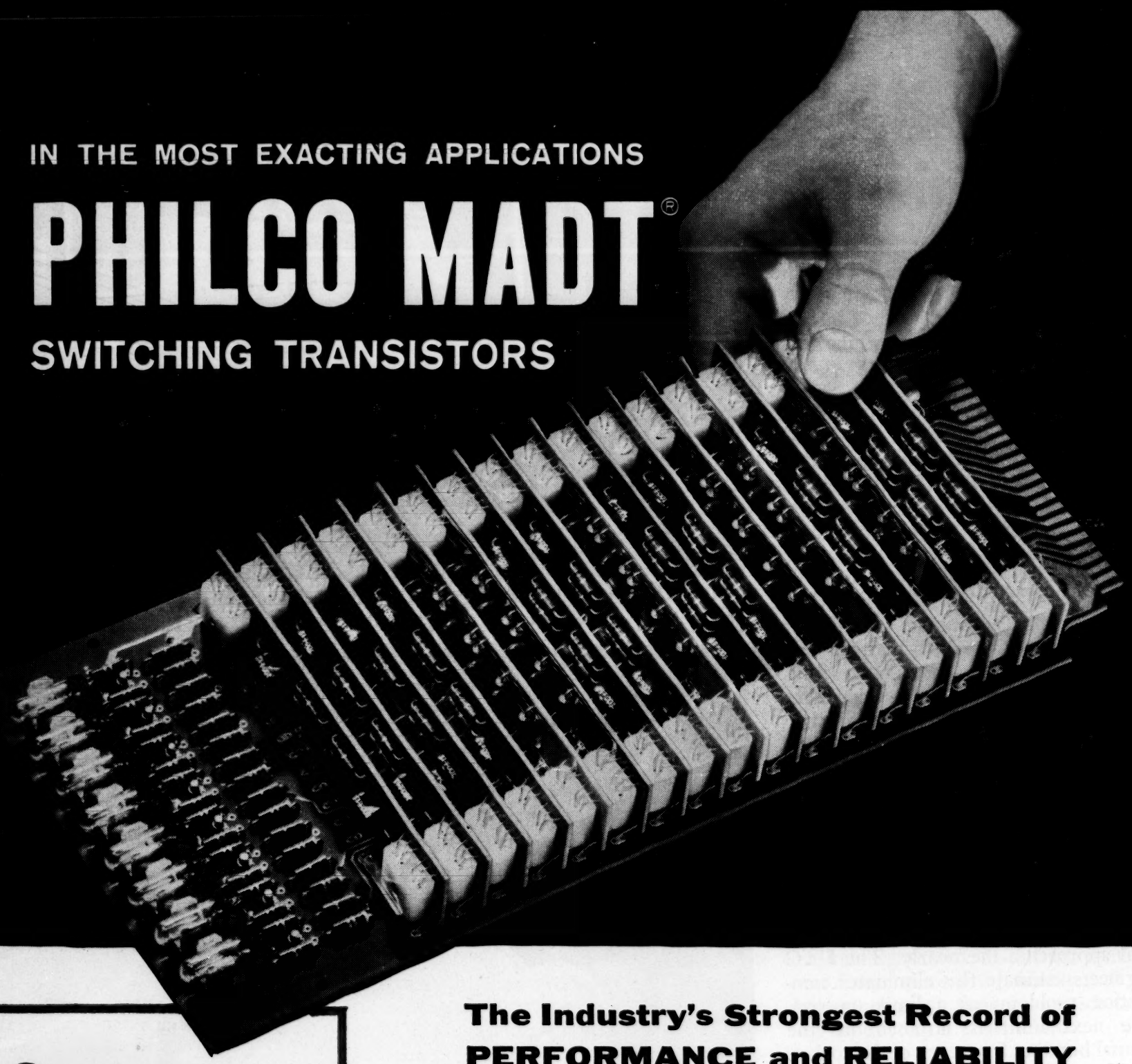

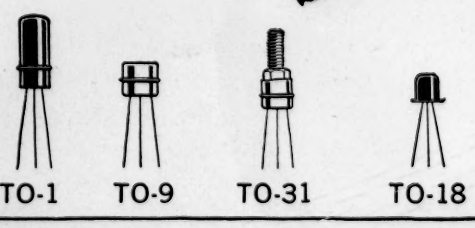

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very slight advantages in lower drag and greater aerodynamic stability.

The largest segments now contemplated by UTC would weigh about 100,000 lb. and have a diameter approaching 20 ft. Many of the new production facilities at the Morgan Hill Development Center are designed for that size. As diameter approaches that size, volumetric loading efficiency drops. To go beyond that size the industry will have to find faster burning propellants.

Engineers found the design of nozzles and other hardware for rockets this size much less difficult than anticipated. Part of this is because nozzle wall thickness does not increase with size. Part of it also is due to the conclusion of UTC technologists that movable nozzle control systems have outlived their usefulness.

UTC plans to use secondary injection of fluids into the exhaust downstream of the throat for thrust vectoring. They admit that the proper choice of fluids and the best injection device and direction have yet to be determined but they are convinced that the technique will prove itself. The result should be a more efficient nozzle than the jetevators and swiveled and gimbaled nozzles most often used in present solid propellant rockets of any size.

Thrust Vector Control

The principle of secondary injection thrust vector control is that blockage of the supersonic exhaust stream will create a diagonal shock wave which ideally should not intercept the opposite side of the expansion cone. Exhaust gas passing through the shock wave is deflected away from the injected fluid. Experiments have shown that the deflection of the thrust line is proportional to the flow rate of the secondary fluid. Engineers at UTC say they have found a valve with the precision necessary to meter the thrust vector fluid. They will accept delivery of some of these shortly.

No problems are expected to arise when two valves are opened to rotate the rocket about both pitch and yaw axes. Herbert R. Lawrence, vice president in charge of engineering, reports that the shock waves are additive in their effect and quite weak so that no troublesome instabilities are set up. Nearly everything has been tried as a thrust vectoring fluid, including water, and everything worked to some extent. Good oxidizers such as nitrogen tetroxide seem to provide necessary exhaust deflection for a minimum expenditure of fluid because solid propellant rockets burn rich fuel and combustion in the stream increases the exhaust blockage. Another promising fluid is Freon. Lawrence reports that the weight of the single nozzle with secondary fluid injection thrust vectoring will be heavier than the four nozzle mechanical systems, but calls the difference minor.

The best method of injecting the fluid is yet to be determined, but Lawrence is convinced that the least promising will show adequate power for the job. For the huge boosters projected by UTC, a maximum exhaust deflection of 2.5 deg. will be sufficient because of their great inertia. A 5-deg. deflection would be enough for a Polaris-size missile or perhaps 8 deg. for abnormal launch attitudes. The comparatively undeveloped liquid injection thrust vector controls which have been demonstrated experimentally have been able to deflect the thrust line 5 deg.

In other experiments it has been shown that the power of secondary injection is between 1.2 and 1.8 times that of a jet with an equal propellant flow exhausting into free air. According to Lawrence, the main problem remaining for this type of thrust vectoring system is how to minimize fluid consumption.

UTC got into the segmented rocket business when National Aeronautics and Space Administration called for proposals from industry for such a system. In response to the request, UTC designed and built the TM-4 series of test motors. The conical design was developed during the TM-4 program. The designers were generally satisfied with the performance of the TM-4 series which enabled them to find the circumferential clevis joint which will characterize future UTC motors.

The problems of sealing and insulation of the joints are obviously fundamental problems for the segmented rocket concept. UTC officials say that the TM-4 series has proven they have the solution to those problems. The weight of the joint and the extra insulation are supposed to cut the mass ratio of the conical segmented rocket by about ½%. The mass ratio of larger rockets now on the drawing boards is expected to be about .88 or .90.

Two other questions are answered by the TM-4 program. It had to show how to burn propellant at the segment joints in such a manner as to minimize the amount of insulation needed on the case joint and demonstrate ease of assembly in the field. The latter point has an important bearing on the usefulness of the concept and UTC engineers were pleased when the circumferential clevis made it possible to assemble the TM-4 in only three minutes. The TM-4 comprised a segment, a nose section and a nozzle but the tests seem to indicate that difficulty of assembly will not be a problem.

Some TM-4 motors were allowed to burn at the propellant face in the joint

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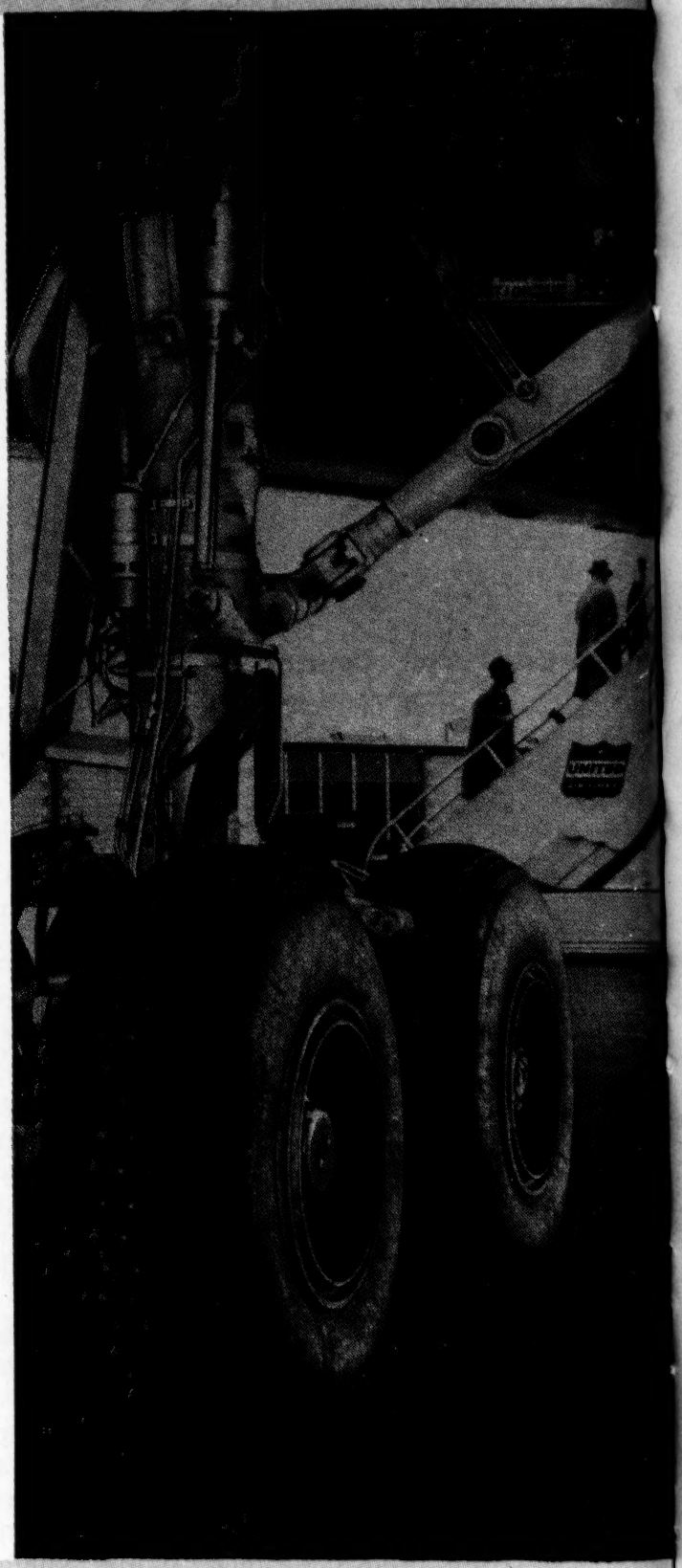

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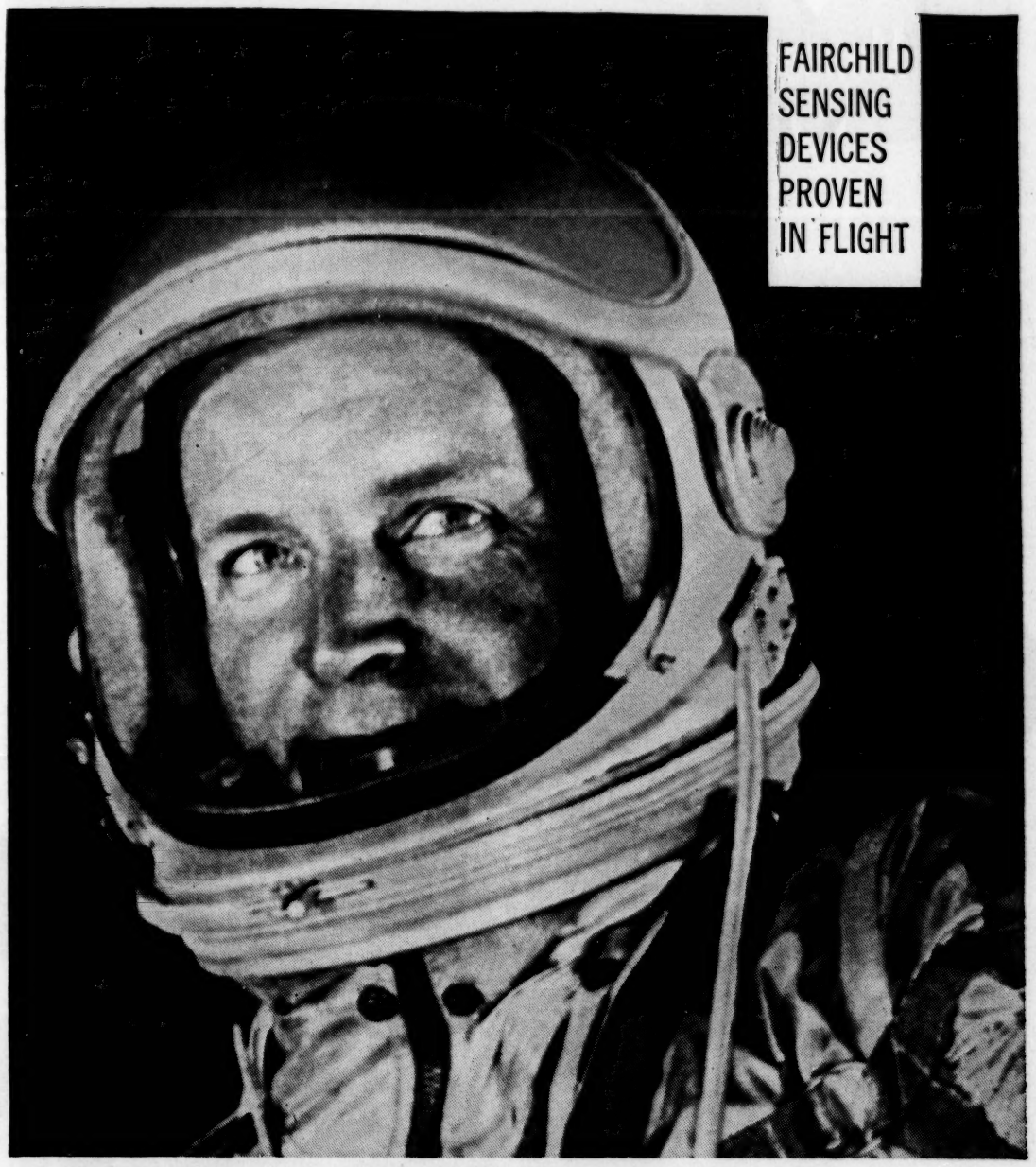
and others had combustion inhibitors there. Heat flux into the case joint was not excessive either way. UTC engineers conclude that with inhibition the flame traveled far enough in its flow toward the wall to let it cool. Without inhibition, they say the flow of hot gas was away from the wall toward the center of the charge port and that this would minimize heating. UTC will probably let the propellant burn at the joint. This will allow it to control burning area more easily for such purposes as thrust on manned vehicles to prevent acceleration from exceeding human tolerances as the weight of propellant burns off.

UTC technologists visualize conical segmented rockets with as many as eight or 10 segments but are only actively developing the two top segments, called S-1 and S-2. Lower segments become progressively larger and cannot be built without government funding. The S-1 and S-2 segments are by no means small. UTC officials say that combined into a single rocket, they could lift a load approximately equal to that of the Douglas Thor boosters now widely used in space projects. The S-2 is to have a 42-in. diameter nozzle throat. The S-1 will be fired for the first time late this summer and the S-2 will be fired a month or two later.

The terms used to describe some of the facilities at the 3,200-acre Morgan Hill site are illuminating. The so-called "small" above ground casting station is capable of making motors the size of a Polaris first stage. The large, in-ground casting and curing oven has a usable diameter of 20 ft., and a depth of about 50 ft. The Travelift hoist to lift the big segments from the oven and carry them around the facility will have a capacity of 120,000 lb. The doors into the large motor final storage building are 20-ft. wide and the storage bays are 40-ft. long.

The four "small" horizontal test bays at Morgan Hill are capable of handling motors developing 250,000 lb. thrust and each bay has a little vertical stand capable of handling smaller motors developing up to 20,000 lb. thrust. The large vertical test bay in a nearby box canyon is designed for thrust up to two-million pounds. Two more such bays are planned for future construction. The motor nozzles are to be pointed upward in the vertical solid propellant test stands and a collar and tether arrangement will be put around the nozzle throat to keep the nozzles from being launched into nearby communities if a motor blows up on the stand.

The development center has relatively standard 250-gal. and 150-gal. propellant mixers. It will take between 22 and 29 batches from mixers of that



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Monsanto research in the chemistry of silicon, phosphorus, ultra-fine metals and oxides, and "super-pure" elements and compounds has found promising leads to improve semiconductors. These materials—developed by the synergistic collaboration of solid-state physicists, inorganic chemists, and physical chemists—forecast improved performance of transistors, photoconductors, thermoelectric generators and coolers, solar batteries, rectifiers, thermistors and other electronic applications that depend upon the tractability and mobility of electrons moving through special composition solids.

Monsanto researchers, from a firm base in the commercial production of semiconductor silicon (under Siemens-Westinghouse license), have found a number of intriguing leads to new and improved semiconductor materials suitable for transistors, rectifiers, diodes, thermoelectric coolers and generators, and Hall-effect devices.

Since the middle 50's—the burgeoning uses of transistors, diodes, rectifiers, as well as thermoelectric, photoelectric, and servo devices, have kept chemists on a dogged search for substances with a given quantum of mobile electrons that would behave predictably. To the "armchair chemist" the semiconductor problem might look deceptively simple: check out a relatively few elements and compounds, purify them highly, dope them in the order of 1:10,000,000 with an element from another periodic group to provide the proper *n* or *p type* conductance; and grow into crystals.

A minimum of experimentation, however, would quickly establish that the chemistry of preparing the super-pure materials and uniformly doping them to produce n-type and p-type semiconductors is one of the most intricate problems that inorganic and physical chemists have ever tried to solve. Not the least of the problem is that no reliable method has been developed to predict the energy gap; all possible combinations and proportions of candidate elements have to be prepared and the energy gap determined empirically!

In attacking this whole problem of semiconductor materials for advanced electronics, Monsanto research is focused on the following four areas of study:

1. PURITY IMPROVEMENT...
of "III-V" semiconductor compounds by at least one or two orders of magnitude over best purity yet available; and, concomitantly, studies of new techniques for converting these high-purity compounds into single crystals. When completed, a variety of new and improved electronic devices can be developed with these high-purity materials.

2. "SPOT" SYNTHESIS AND SCREENING...
of candidates in numerous classes of compounds for organic semiconductors—compounds where structural concepts point to the compounds' ability to shift electrons. (In organic semiconductors, too, uniformity and purity are vitally important.)

3. NOVEL CHEMICAL PROCESSES...
are under intense study for the preparation of compounds of group "II-VI" type semiconductors.

4. NEW INORGANIC SEMICONDUCTORS...
i.e. gallium and indium arsenides are now available for research and development. Doping of gallium arsenide is in progress.

A major purpose of this semiconductor chemistry research is to find materials with greater reliability over a wider temperature range, the ability to function at high temperatures, and variously with improved electrical, photoelectric, thermoelectric, magnetic, and photoconductance properties. By intensifying—chemically—the electronic property sought, improved devices based on these properties will become feasible. In collaboration with electronics manufacturers, the materials now on the horizon will serve in telemetry, automation monitoring devices, guidance computers, ignition systems, and communications equipment. These materials will also open the door more widely for increasing the efficiency of thermoelectric power generation, thermocooling devices, and photoelectric power generation. Promising leads are under study in "III-V" semiconductors of indium, gallium, and boron phosphides;* in new "II-VI" compounds and others.

(Please turn page.)

**F. V. Williams and R. A. Ruehrwein, J. Am. Chem. Soc., 82, 1330-2 (1960); D. E. Hill and B. D. Stone, Physical Review Letters, 4, 282 (1960).*

THE BROADENING SPAN OF CHEMISTRY FOR ELECTRONICS

Monsanto researchers have already produced a variety of unique materials chemically tailored for the particular needs of electronic engineers. These materials range from liquid dielectric coolants for "packaged" units to singularly pure, reliable-performance large crystals of meticulously doped silicon. Many more, however, like the following, are in various stages of development:

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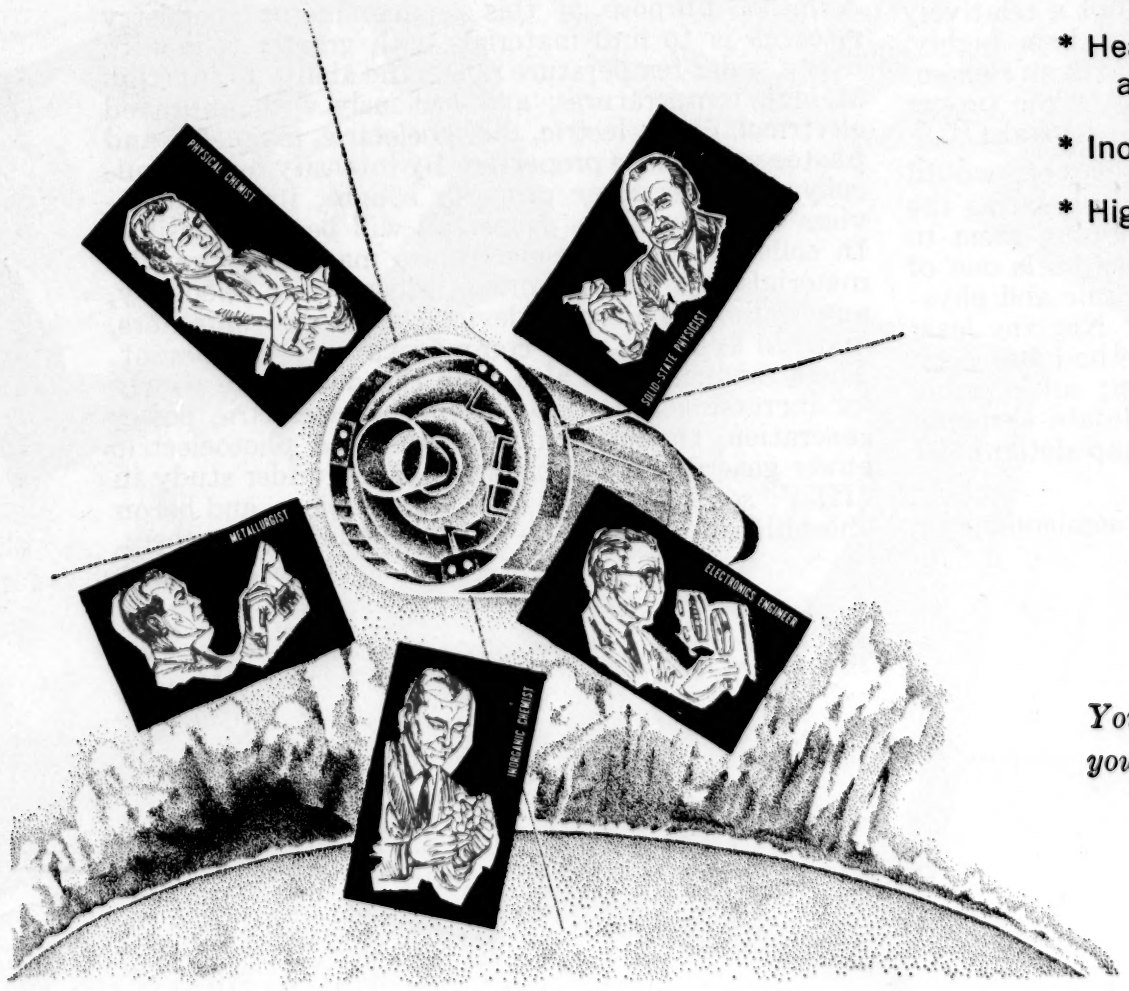

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* Fire-Resistant Hydraulic Fluids for Ground-Support and Missile-Launching Equipment
* Radiation-Resistant Heat-Transfer Fluids
* High-Temperature Lubricants and Additives
* Radiation-Resistant Reactor Coolant-Moderators
* Intermetallic Semiconductor Materials
* Pure Silicon for Transistors, Rectifiers, Diodes
* Ultra-Fine Metal Oxides
* Materials for Vibration Damping
* Heat-Resistant Resins for Laminating and Bonding
* Inorganic Polymers
* High-Energy Solid Propellants

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size to fill the big motors to be made in the large in-ground oven. A large segment can be cast in about one day. Two medium-size ovens at the development center will handle motors up to 14 ft. in diameter.

There are also liquid propellant rocket facilities at the development center but the largest test stand is designed for a limit of 50,000 lb. thrust and has plumbing adequate for 300-sec. firings. This stand will be used in hybrid rocket tests scheduled for next spring. Advanced propellants including light metal fuels and fluorine-rich oxidizers are expected to put hybrid specific impulse up around 300 sec. UTC interest in hybrids is primarily for big booster applications and this will probably dictate early interest in more conventional oxidizers and rubber fuels.

Interesting solid propellant research at UTC includes a plan to produce propellant grains of spherized propellant capsules.

NASA Asks for Bids To Build Simulator

Washington—Construction industry is being asked to bid on a two-phase program to design and build a simulator and dynamic test chamber at National Aeronautics and Space Administration's Goddard Space Flight Center.

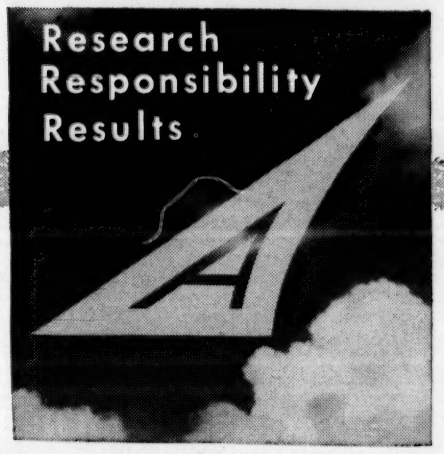
Bids for the job, expected to cost $7.3 million for construction and equipment, are due Apr. 10. Design phase will begin when the contract is awarded and will be completed by August, and construction of the dual facility must be completed by Oct. 31, 1962. Contract for instrumentation will be awarded in a separate competition.

The system will consist of two vacuum chambers, each with a 30-ft. by 40-ft. test section able to accommodate weights up to 40,000 lb. Space environment simulator chamber will have a vacuum pressure of 10^{-8} mm. of mercury following a 24-hr. pumping cycle. Pressure of 10^{-6} mm. of mercury must be attained in four hours.

Diffusion pumping will be done by 25 32-in. pumps, and provision will be made for cryogenic pumping to control wall temperatures from −150F to 212F.

Specifications call for a solar simulator with a plus or minus uniformity of 10% and 8 deg. collimation. Intensity range variation will be from 0.3 to 4 microns.

Instrumentation will include a mass spectrometer, 100-channel tape recorder, 100-channel analog to digital computer, and 400-channel data logger.



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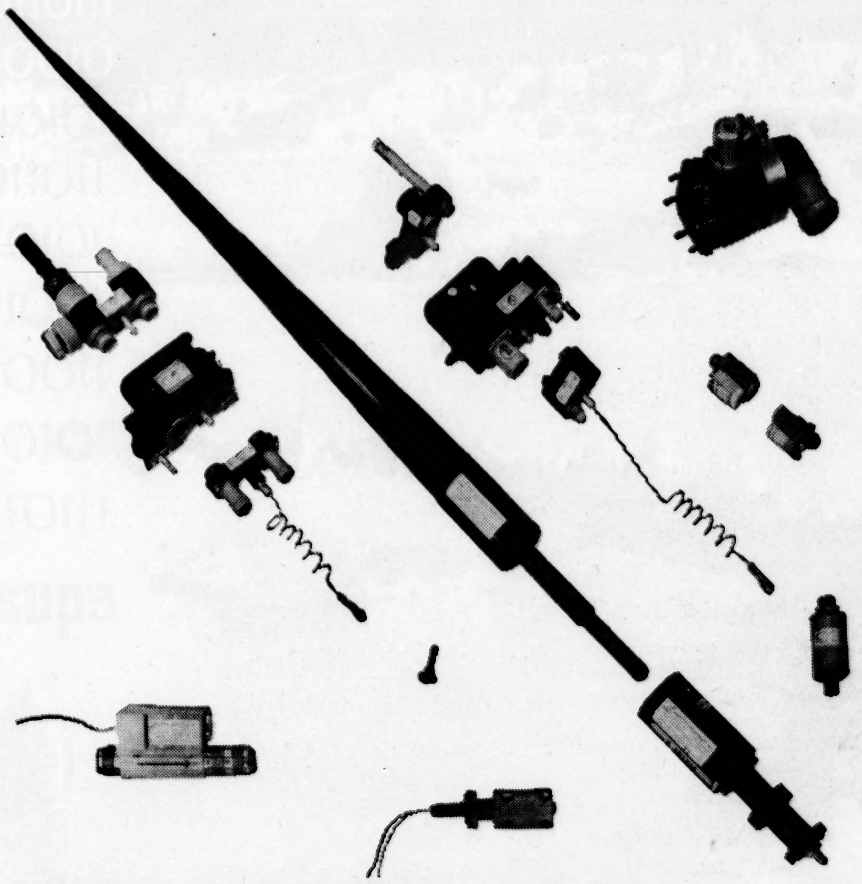

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The more advanced our scientific ventures into space become, and the more sophisticated the weapons in our defense arsenal grow, the greater need there is for special purpose computers engineered to fit system requirements exactly. Serving as the nerve and intelligence center, the computer is playing an increasingly important role in system performance and reliability.

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SPERRY

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Glass-Fiber Blade Boosts Endurance 70%

By David A. Anderton

Bloomfield, Conn.—An all-glass-fiber rotor blade is being flight-tested on an H-43B helicopter here as part of a development program by Kaman Aircraft Corp. to improve blade fatigue resistance and reduce fabrication costs.

Next step in the program will be technical evaluation by the U. S. Air Force, which the company hopes would lead to production of the blade and retrofitting of H-43s already in service.

The new glass-fiber blade, flying as one of the twin intermeshing rotors of the H-43 series, is identical in dimensions and physical properties to the other composite blade fabricated from laminated spruce and maple. But it shows a 70% higher endurance limit than the standard blade, and in production would cost substantially less.

Experience Factor

Kaman's experience with the blade design and development program, plus the company's other work with glass-fiber parts for production helicopters, is expected to feature heavily in its entry in the Army Light Observation Helicopter competition (AW Mar. 6, p. 26).

Key to the strength of the rotor blade is 3M Scotchply cloth, made by Minnesota Mining and Manufacturing Co., which has unidirectional fibers. This cloth has parallel filaments, is about 70% glass, and has an ultimate tensile strength of about 75,000 psi.

In addition to the high absolute strength of this particular fabric, there is a major advantage in being able to tailor the relative strength of a rotor blade by orientation of the fabric. A structure can be fabricated to show maximum resistance to tension loads at one portion and to torsion at another, with optimum distribution of stresses between.

H-43 Rotor Blade

This is the case with the Kaman H-43 rotor blade. There are two highly stressed blade regions: the retention area at the root, and the torsion area, lying between the blade's servo flap and the root.

One major reason spurring development of the glass-fiber blade was extension of the flight envelope for the rotor system. The intermeshing Flettner-type rotor had to increase its load-carrying capability considerably as the helicopter itself grew through the H-43A to the B model now in production. Increased loads meant higher stresses on the blade, and it was quite obvious that existing composite blades would need strengthening, if not complete redesign.

So step by step a new blade design evolved from additions to the composite blade and parallel development of structural components by Kaman engineers. They first tackled the problem of the retention area, reinforcing the grip area with a $\frac{3}{8}$-in. thick premolded cheek added to top and bottom of the maple cheek plate.

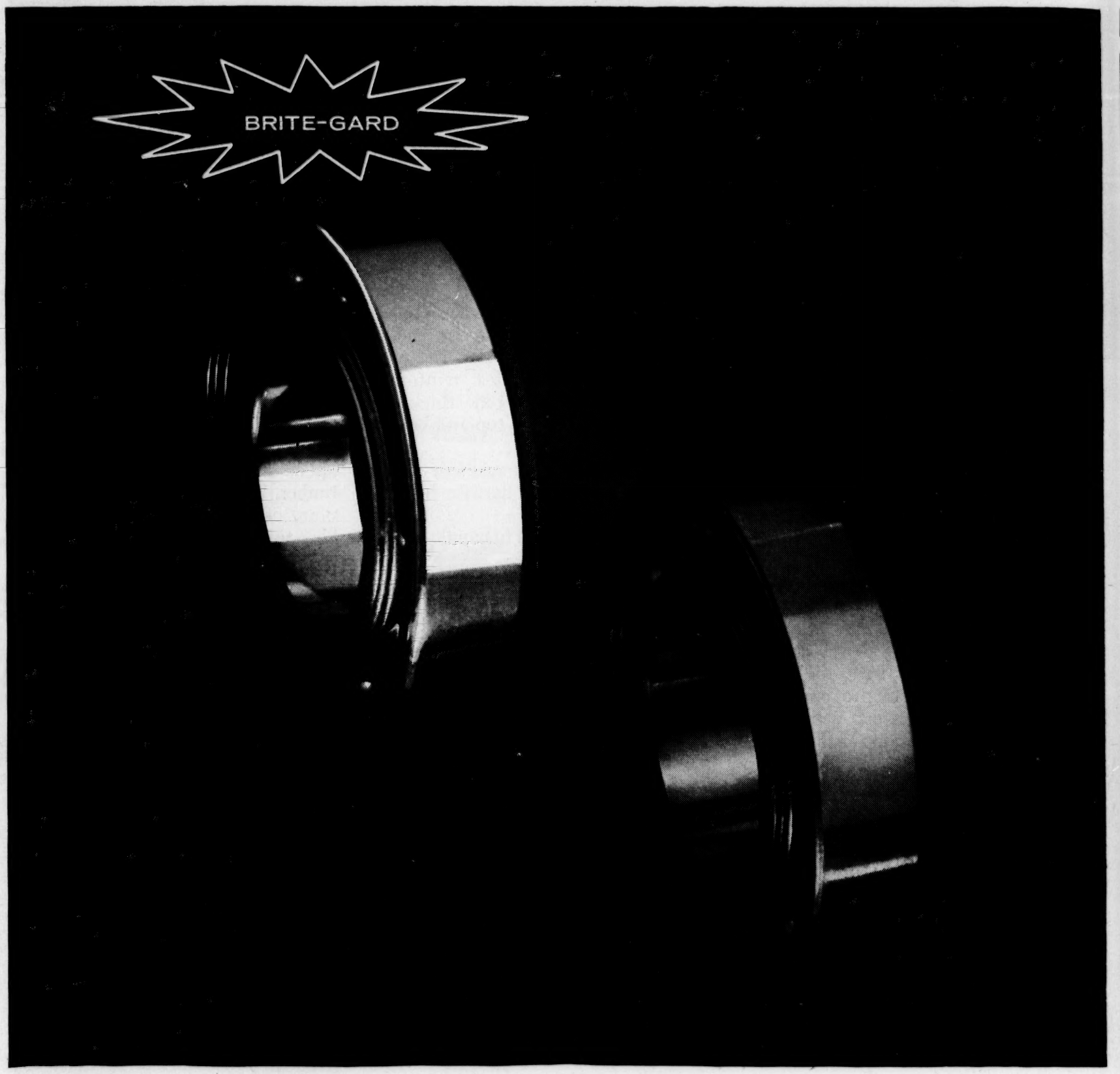
Purpose of this reinforcement was to increase the vibratory flatwise bending capability.

This was not enough to handle further expansion of the flight envelope, so a $\frac{1}{8}$-in. steel plate was added to increase the endurance limit.

Differences in modulus of elasticity between the steel doubler on the glass-fiber cheek on the maple cheek plate made this three-way composite design undesirable, so the designers specified a change to a $\frac{1}{8}$-in. Scotchply plate replacing the steel cap. Besides making a more compatible structure—the modulus for glass fiber is about that of wood—the endurance limit was increased by almost 40%.

Then $\frac{1}{2}$-in.-thick side walls were laid up of glass fiber to reinforce the core timber, but keeping the original dimensions of the root section. With this fiber tube in place, the core timber was

GLASS-FIBER ROTOR BLADE has been developed by Kaman and is being flight-tested on an H-43B helicopter. Blade is completely constructed of 70% glass fiber, with structural properties of the spar tailored to match the stress conditions. Section aft of the spar is non-structural, duplicating geometry of standard composite blade used on H-43 series.



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removed because it no longer was primary structure. Result: a bending endurance of ±45,000 inch-pounds, 30% higher then the maximum measured moments during the high-speed flight regime.

While the redesign of the root section was under way, similar steps were remaking the torsion section. The original composite blade spar, made of spruce and maple laminations, was capped with a leading edge of 0.018-in. stainless steel to protect against erosion and to take a portion of the bending and torsion loads. By wrapping one layer of woven glass fiber around the leading edge, the endurance limit was boosted substantially. This C-shaped wrap and the stainless steel leading edge cap were replaced by a six-layer D-wrap which further raised the endurance limit.

Final step was to replace the D-wrap with a complete D-shaped spar section fabricated of a 10-layer Scotchply nose section bonded to a 15-layer glass-fiber vertical web. The timber core was removed as nonessential.

With both the retention and torsion areas completely redesigned to use only glass fiber, the logical next step was to do the entire blade that way. These two sections were incorporated in a new blade design which added to them an all-glass-fiber trailing edge section, duplicating geometrically each structural element of the old composite blade in glass fiber. This was the final blade.

Testing of the design followed the standard pattern of whirl and flutter tests and loads up to +3g and −0.5g. Endurance limit at 30 x 10^6 cycles was determined to be ±3,600 inch-pounds, 70% higher than the composite blade.

The finished blade is translucent behind the spar and the characteristic greenish color of laminated glass fiber on the spar. Color pigments can be used during fabrication so there is no need for supplementary finishing.

Kaman's experience with glass-fiber parts is not confined to blade sections. Major portions of non-primary structures of the HU2K-1 Seasprite helicopter are made from the material. But the rotor blade is currently the best example of the use of glass fiber tailored to do a specific job and to produce better results for less money.

There are many advantages to using glass fiber for part production, and these have been enumerated many times previously. The low cost of tools, the adaptability of the processes to low-cost production for quantity runs between prototype and all-out production, and easy repair in the field have all been cited.

But there are some drawbacks. Kaman designers say there is a need for standards for raw materials, and that quality and physical parameters can vary considerably if not carefully watched. Precise control of the lamination or bonding processes is required because the strength of finished parts depends largely on the processing.

Cleanliness is essential in fabrication, and this means extra care in planning and operating a production facility. There may be need for premium pay, protective clothing and extra wash-up time because of some of the chemical substances used in the processes.

But with special attention paid to quality control, and with the knowledge and imagination available in designers, Kaman feels that glass-fiber parts are the best answer to high-volume production of components.

Superheating Reduces Skin Friction Drag

Major reductions in skin friction drag of a hydrodynamic body have been achieved in tests at Convair Division of General Dynamics' Scientific Research Laboratory, San Diego, Calif.

A superheated graphite body was towed underwater at 20 fps. The reduction in skin friction drag, caused by the lubricating layer of gas formed by contact of the hot body with the water, amounted to more than 90%.

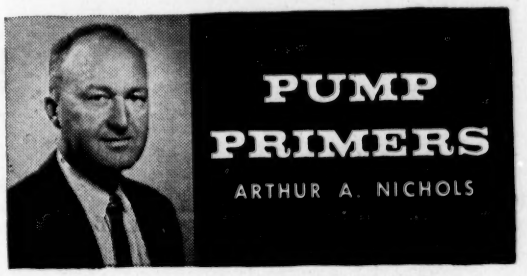
The superheating technique is one of several methods that could be used to achieve the same results. The gas could be bled from the leading edge of the underwater vehicle to form the lubricating envelope, or the leading edge could be made of some material that would react with water to produce both heat and vapor.

This approach is an extension of techniques which have been tested experimentally on surface vessels. Russian engineers have reported significant reduction in the friction drag of boat hulls by bleeding high-pressure, superheated steam through orifices at the stem of a ship.

Parallel technique has been suggested as one method of reducing the skin-friction drag in hypersonic flight regime (AW Feb. 6, p. 23). National Aeronautics and Space Administration tests report up to 60% drag reduction by injection of helium into the boundary layer of a test model at Mach 5.

Convair tests were made with a graphite shape 1-ft. long and 1½ in. in diameter. The graphite model was heated to 2,000F before immersion in the towing tank.

Applications of the technique could be made to either a purely hydrodynamic body, such as an underwater missile, a torpedo or a submarine, or to a vehicle that traveled only part of its trajectory in the water, such as the Polaris missile.



HIGH PUMP RELIABILITY IN SEVERE ENVIRONMENTS

► Engineers concerned with drives, auxiliary power sources, gear boxes and various transmission design problems involving pressure lubrication have found Gerotor type pumps extremely useful in their attempts to hold weight down and achieve maximum compactness with high service reliability.

► The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet port to the outlet. (See Figure 1). Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.

Fig. 1

► Low relative speed and closely held clearances between the two Gerotor elements mean high mechanical efficiency is maintained.

► Slow opening of the chamber as it traverses the large inlet and discharge ports results in avoidance of the sudden shock, rapid pressure change and turbulence which, in other types of pumps, results in foaming and lowered efficiency. Thus, Gerotor pumps offer exceptionally good performance at high altitude.

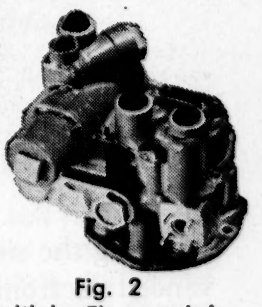


Fig. 2
Multiple Element Lube and Scavenge Pump

► Engineers find the Gerotor pump most attractive because there are several convenient variables that can be adjusted to meet the application requirements: Gerotor *diameter* which governs the area of the pumping chamber, Gerotor *thickness*, which, taken with area, determines *unit volume* per revolution and *RPM*. Thus, it is possible to vary the diameter, length and speed of the pump elements to secure wanted capacity. In addition, the porting of this type of pump is completely flexible in location, making for ease of fitting adaptability to the available space and geometry of the engine structure.

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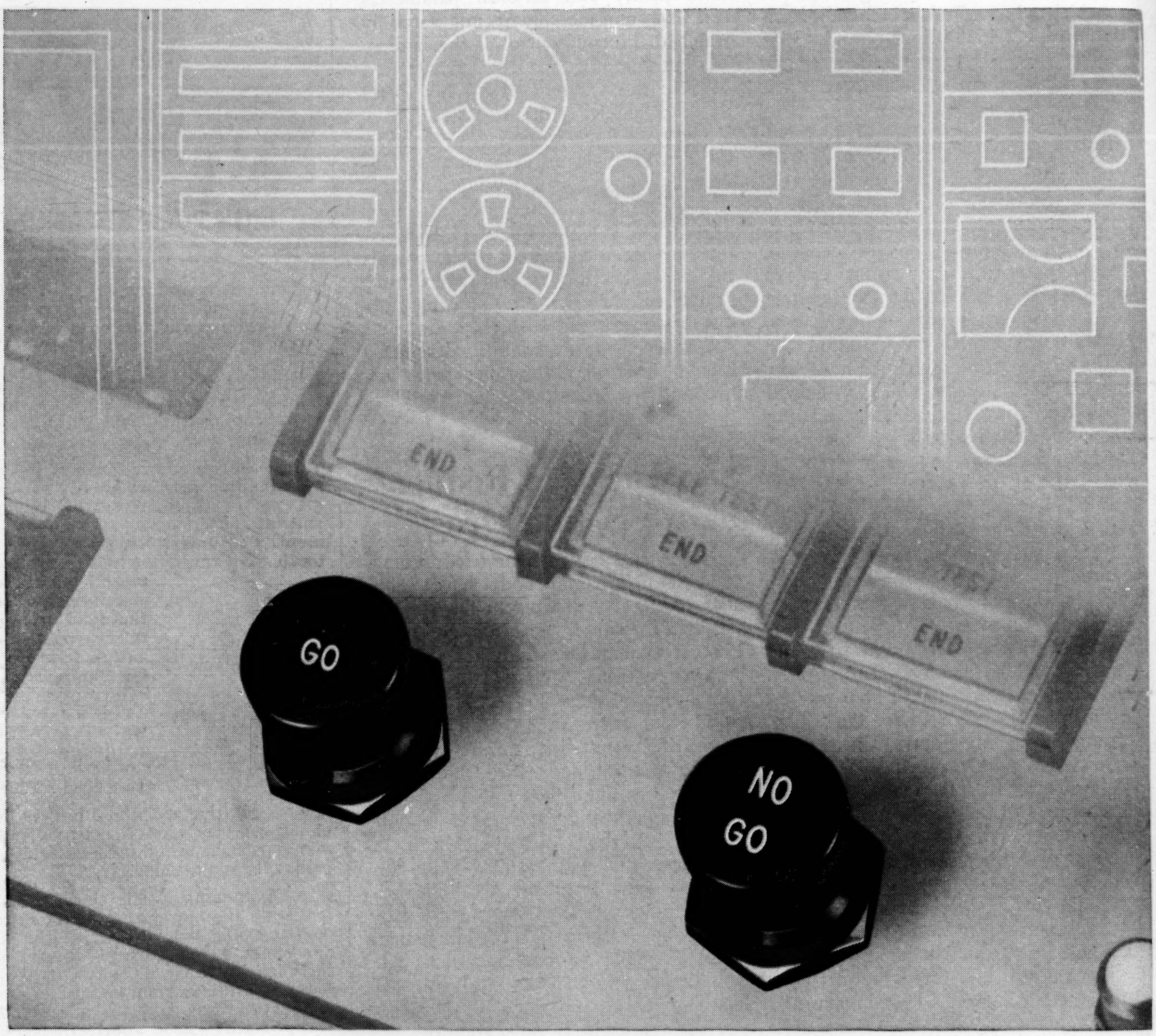

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RADIATION
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Army Seeks Helicopter Overhaul Savings

Ft. Worth, Tex.—Good maintenance record of an aircraft starts with careful attention by every member of the manufacturer's engineering department to ensure that detail design work is exact and correct from the first lines drawn on paper, Lt. Gen. William B. Bunker, commander, U.S. Army Transportation Materiel Command, told local American Helicopter Society members here.

Minor detail design errors, rather than mistakes on the part of the chief engineer, are largely responsible for keeping TBO (time between overhaul) periods down and ensuring that they increase at an "agonizingly slow pace," Gen. Bunker stated. He said that designers should bear in mind during their original thinking in a new aircraft design for Army that 1,200 hr. before overhaul of time-change components is the goal to shoot for at the start, rather than an achievement to be accomplished during a cost-plus modification program some four or five years after the aircraft enters operational service.

Spares Problem

Army experience in the past as regards spares requirements for maintenance support has actually turned out to be so erratic as to preclude capability of predicting with certainty spares purchasing needs, Gen. Bunker indicated. "If I buy a set of spare transmissions based on your need predictions and then the TBO experience turns out more favorable than considered, then I'm stuck with this inventory," he noted.

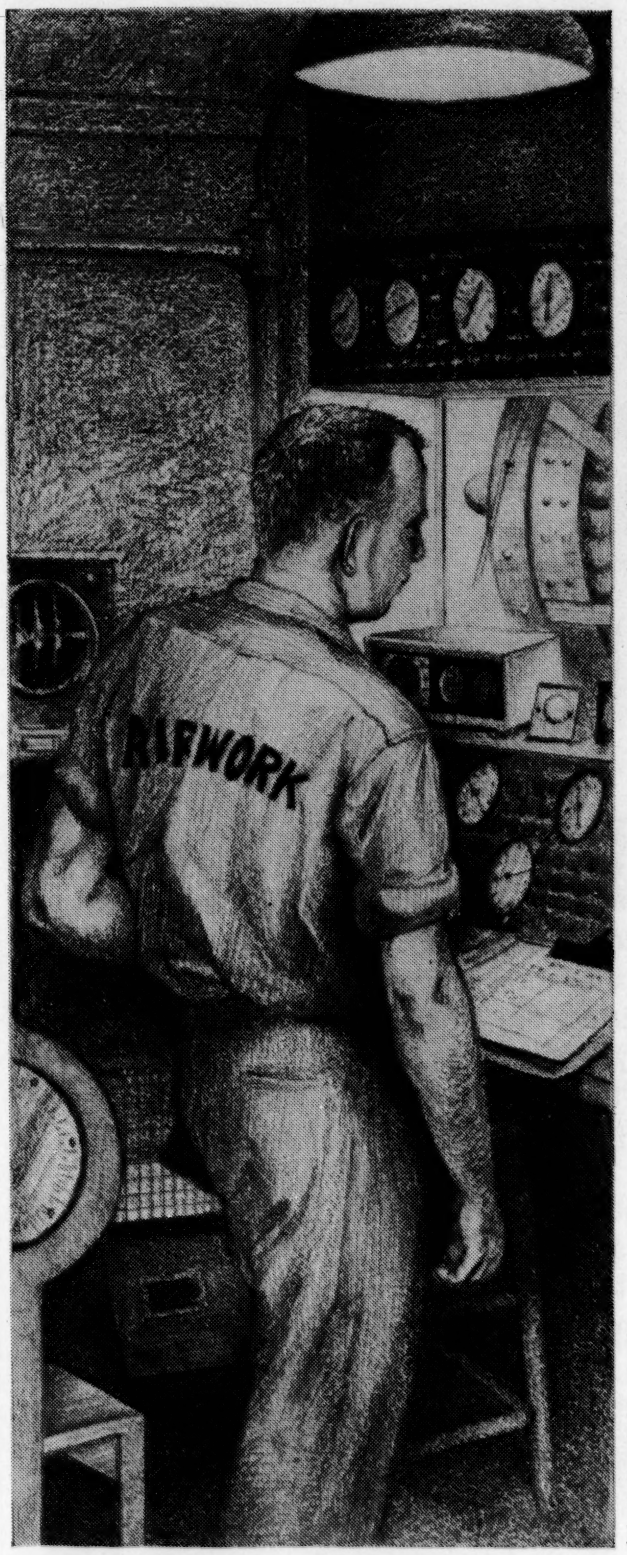
In some instances, statistics indicate that component reliability records show such a marked scatter, that for all intents and purposes Army might as well buy on a pull-and-replace concept rather than attempt to stock everything needed to be safe, and economically this appears to be highly unfeasible.

Example of Savings

As an instance of how increasing time between overhauls of major components can result in marked saving of Army dollars he noted that the HU-1A costs an estimated $200 per flying hour on current 300-hr. TBO. If it attains the goal of 750 hr. considered for January, 1962, costs will be down to $8 per hour and if it reaches the 1,000-hr. TBO mark considered for January, 1963, costs will be down to $6 per flying hour.

A means of cutting maintenance costs and increasing safety by development of an aircraft "self-maintenance" program was mentioned by Gen. Bunker. Basically, the concept would entail installation of electronic equipment in Army aircraft. Sensors would record vibration, temperatures and other parameters on major components, much along the lines of engine analyzer systems which have been useful in spotting incipient problems in flight. This permits replacement prior to their becoming a safety hazard or at a time convenient to maintenance personnel.

Gen. Bunker noted that this so-called "alarm" plan is now being studied in breadboard form for an HU-1. Currently under study is the number of pickups desired. Army plans to have an operational system ready for installation on all HU-1s in 1962. The program calls for data to be transmitted to the ground to cut down in-flight black-box weight and size. Such a system is envisaged as eventually eliminating need for current formal time-between-overhaul requirements.



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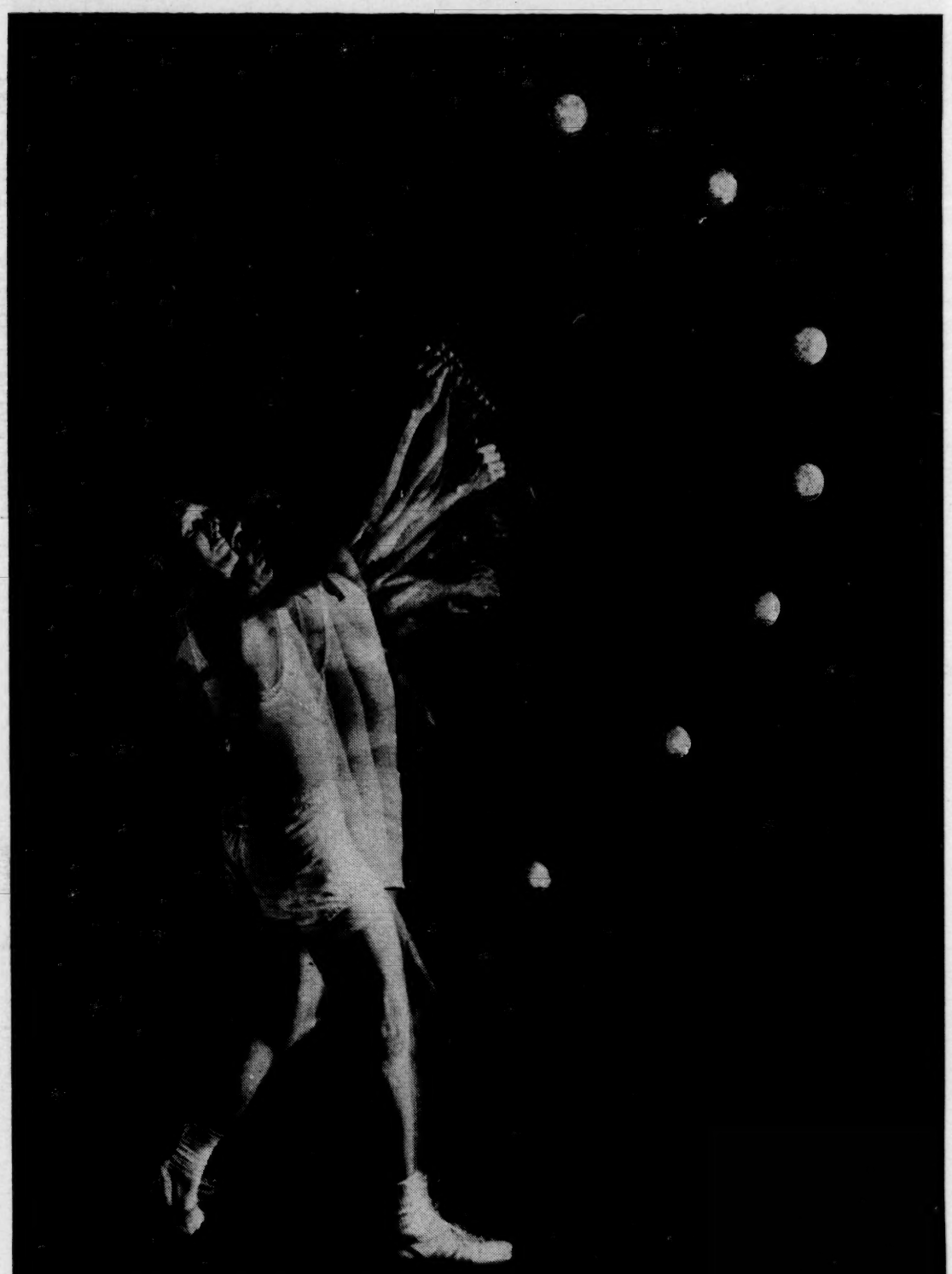

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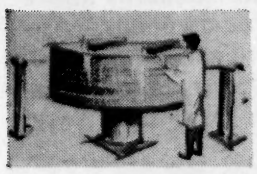

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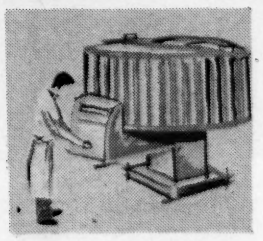

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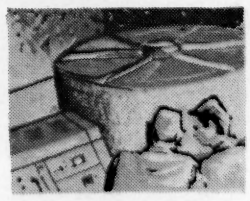

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PRODUCTION BRIEFING

Western Electric Co. has received two Army contracts totaling $6,200,000 for work to be performed on the Nike Hercules missile system. The first award for $5 million covers production of ground equipment, the second for $1.2 million is for production of missile test equipment.

Wyle Laboratories has received a $40,710 contract from the George C. Marshall Space Flight Center for a high-accuracy flow meter for use with liquid hydrogen. The work will include a study of the state-of-the-art in instrumentation for mass flow measurement, with a resulting modification of available instruments to provide accurate and reliable measurements for liquid hydrogen.

General Tire & Rubber Co. has been awarded a production contract by McDonnell Aircraft Corp. to manufacture the main landing gear wheel, brake and tire, nosewheel and nosewheel tire for the F4H-1 Phantom.

Air Research and Development Command at Andrews AFB has been awarded a $150,000 contract from the Marshall Space Flight Center in support of Saturn studies being conducted by Convair-Astronautics. The funds will cover additional studies and preliminary design of the S-V stage for the Saturn C-1 vehicle.

Bendix Corp. has authorized construction of an advanced type of space chamber and associated equipment for environmental tests of satellites and space systems. The facility will be capable of testing full-scale satellites under rigorous conditions of heat, cold and vacuum. Present backlog of orders for Bendix is $473 million.

Chrysler Corp., Missile Division, has received a $79,220 contract from the Marshall Space Flight Center for a study of corrosion and corrosion prevention in the Saturn rocket. The study will entail location of all potential corrosion areas, an evaluation of the effects of corrosion on the operation of various components, and an evaluation of presently used or proposed protective treatments.

Texas Instruments' Apparatus Division, Dallas, Tex., has been awarded two contracts exceeding $600,000 total by Minneapolis-Honeywell for electronic flight controls for USAF-Martin Titan and Chance Vought Scout. Titan contract calls for production of a transistorized package that controls

12 different flight functions within an accuracy of 0.006 sec. Earlier models of the subsystem have been used on long-range Titan flight tests. The Scout system will use new logic design but the basic techniques employed in the Titan package will be applicable.

Melpar, Inc., has been awarded a $1.7-million Navy contract to produce two operational flight trainers for the A4D-2N weapon system. The devices simulate the full weapon capability of the aircraft as well as emergency situations and instrument flight conditions.

Chicago Aerial Industries, Inc., has received two defense contracts totaling more than $2 million. Major item is a $1.5-million order for an undisclosed number of aerial reconnaissance systems for the F8U Crusader. Second order, in excess of $500,000, calls for delivery of blade trackers to all Navy helicopter bases. The blade tracker is a safety device that balances and positions rotor blades, eliminating blade failure.

General Electric Co. has received a contract in excess of $3 million from the Vertol Division, Boeing Airplane Co., for 50 helicopter gas turbine engines. The engine, GE's CT58-110, is a commercial counterpart of the military T58-8 turboshaft powerplant.

Safe Flight Instrument Corp., White Plains, N. Y., will provide KLM Royal Dutch Airlines with its SCAT visual flight control system for installation in a Douglas DC-8. The SCAT system (AW Oct. 17, p. 92), will be evaluated on both training and operational flights.

Ortholog Division of Gulton Industries, Princeton Junction, N. J., has developed an analyzer which can reduce missile flight data while in flight. Recently tested aboard an Army Research rocket fired from White Sands, N. M., the Ortholog vibration and acoustic analyzer handled five channels of wideband data, reducing it to final form simultaneously with the flight of the missile.

Air Force Missile Test Center, Cape Canaveral, Fla., has replaced its IBM 709 computer with the faster, more versatile IBM 7090. Computer will be used for data processing and impact predictions on Atlantic Missile Range launches, as well as collating data on satellite ephemerides (tracks).

U. S. Army accepted delivery of first complete Sergeant industrial production system from Sperry Rand Corp., Salt Lake City, Utah. The production version will be used at Redstone Arsenal, Ala., for training missilemen.

Photographed at Portland International Airport, courtesy of United Air Lines.

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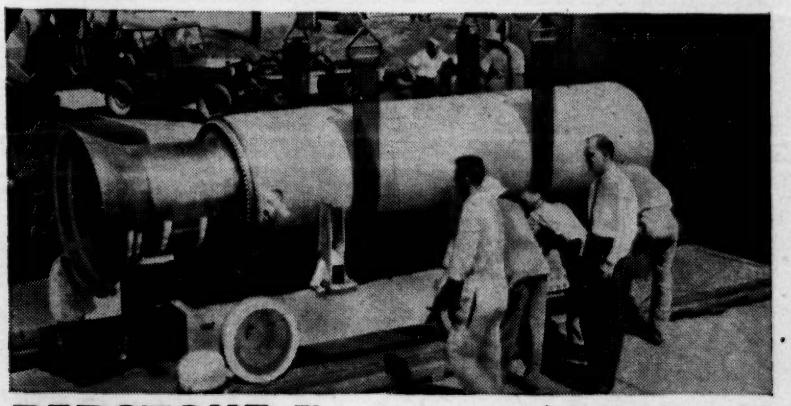

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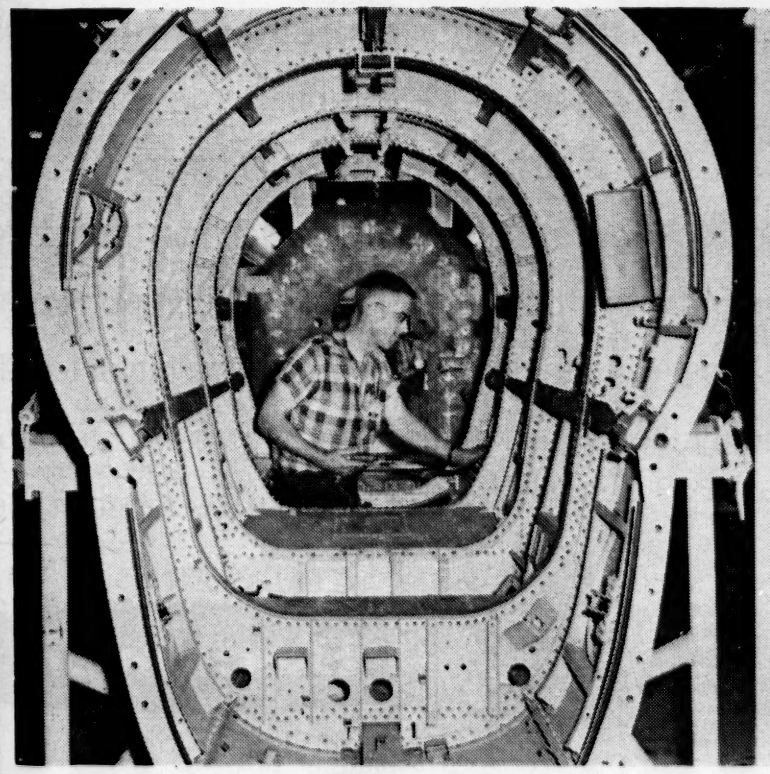
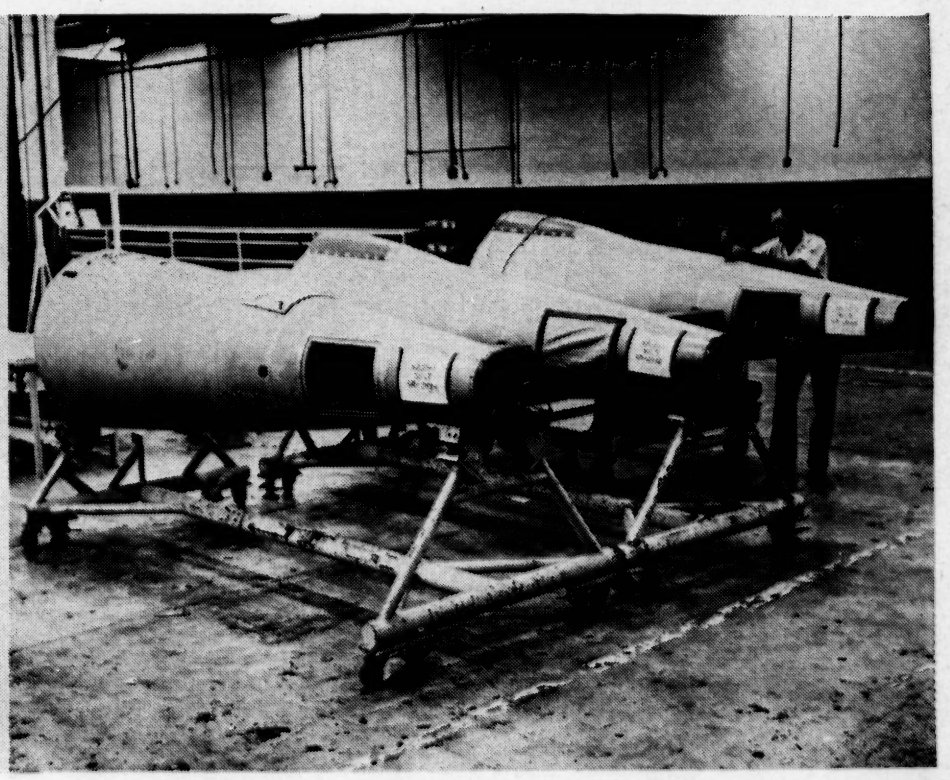
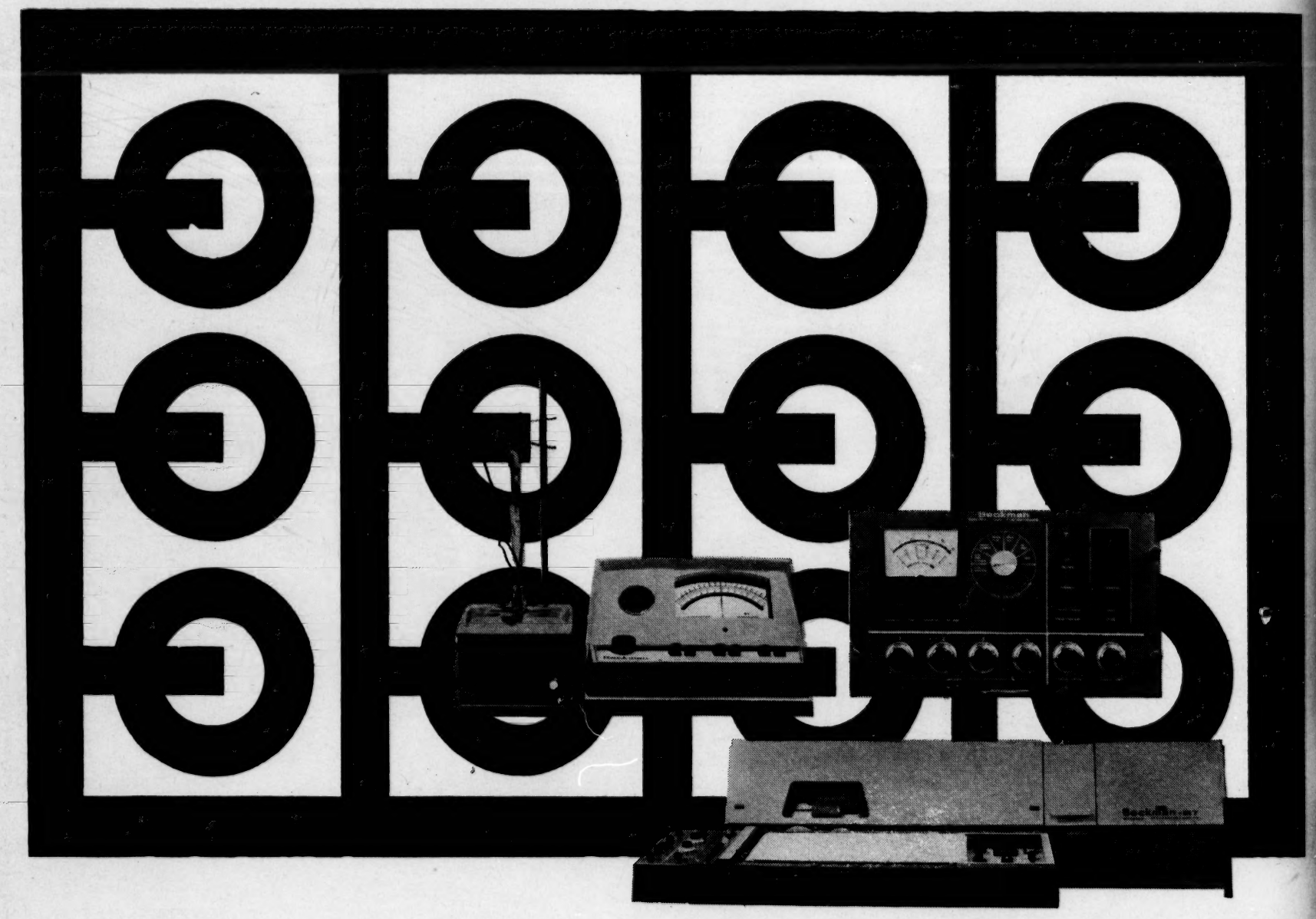
Chance Vought is producing KD2U-1 supersonic drone versions of the canceled Regulus II missile for Navy and Air Force. Air Force uses the drones as Bomarc missile targets at Eglin AFB, Fla. Navy uses the KD2U-1 to test Sidewinder, Sparrow and Terrier missiles at Navy Air Missile Test Center, Pt. Mugu, Calif. Recent $3,260,000 Navy contract calls for conversion of tactical version of Regulus II into KD2U-1s by installing landing gear and making other internal changes. Dallas, Tex., assembly area is above.

Chance Vought Produces Drones for Navy, USAF





Frame is installed at left in aft section of a USAF KD2U-1 drone. At right, access panel is installed on completed nose section. Tricycle gear and drag parachute are designed to cut landing rollout to less than 6,000 ft. after 250-kt. touchdown.



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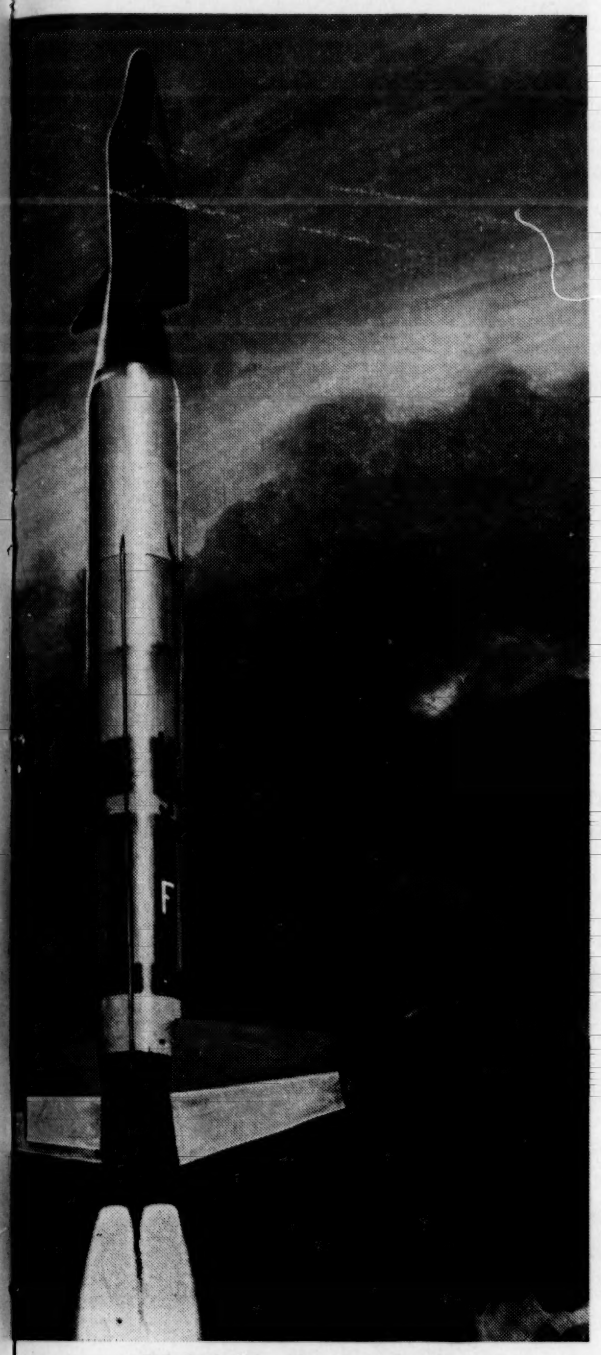


USAF Dyna-Soar

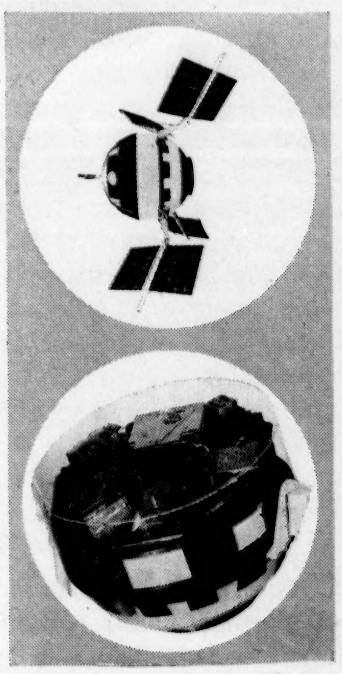
USAF-Martin Dyna-Soar boost glide vehicle as presented in artist's conception will be lofted into space by the Titan II booster.

Battelle Investigating Cryogenic Effects

Battelle Memorial Institute is researching low-temperature performance data on 14 metals used in valves and other missile components subjected to the low temperatures of liquefied fuels.

Tests included measurements of fatigue properties made with metal samples immersed in liquid hydrogen. Size of the samples was 1.2 x 1.6 in., and thickness ranged from 0.020 to 0.080. Cycle rate of the fully reversed plate-bending experiments was 5,200 times per minute. Each specimen is checked at −110F, −320F, −423F and room temperature.

Battelle's work is in cooperation with National Bureau of Standards Cryogenic Engineering Laboratories. Work is sponsored by Wright Air Development Division and Ballistic Missile Division, both of USAF's Air Research and Development Command.



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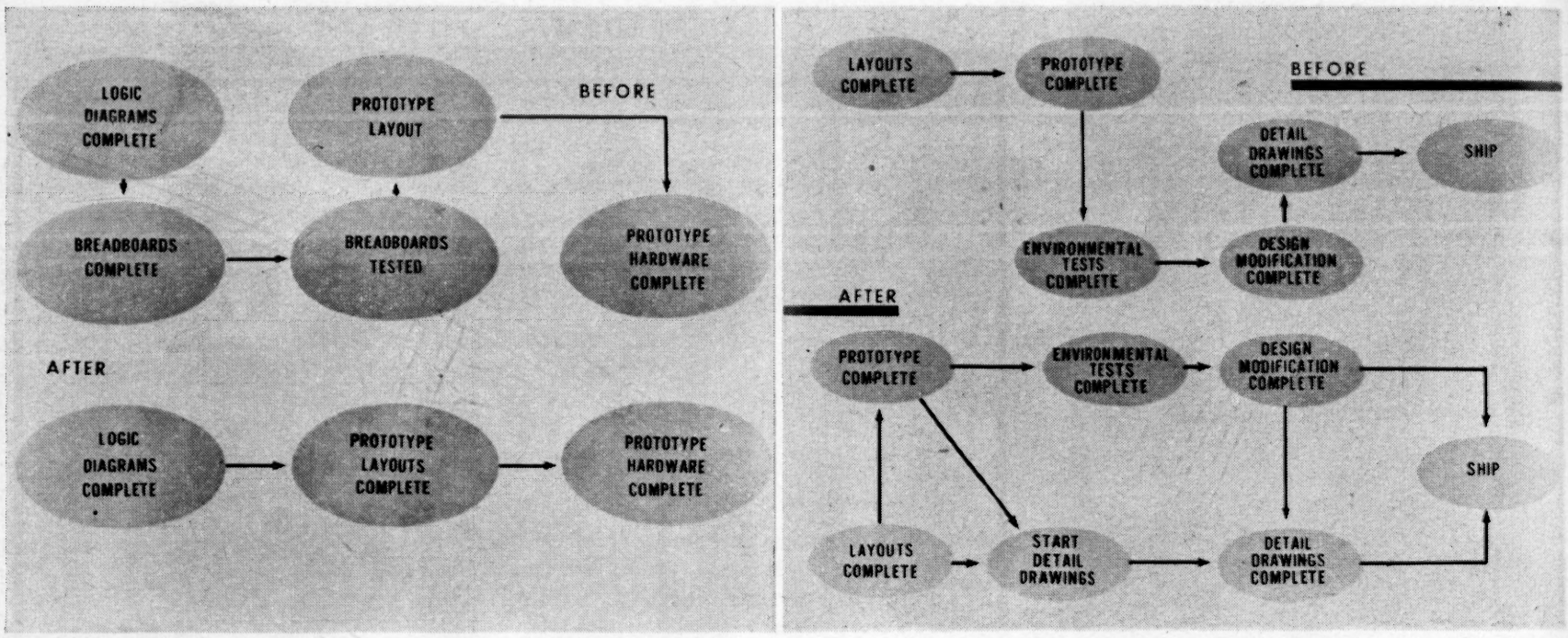


SUCCESSFUL use of Navy-developed PERT management techniques requires that initial time-estimates not be altered under pressure to improve schedule unless portions of originally planned work are eliminated (left) or activities originally planned to be carried out in series are replanned for parallel activity (right).

PERT Plan Eases Management Problems

By Philip J. Klass

Navy's Program Evaluation Review Technique (PERT) has proved a powerful tool for working level engineers as well as for management, a General Electric spokesman reported at a recent three-day American Management Association seminar on PERT.

An enthusiastic endorsement for PERT came from Ernest O. Codier of GE's Light Military Electronics Dept. (LMED), which voluntarily adopted the technique nearly two years ago and now applies it almost across the board in its operations (AW Nov. 28, p. 85).

"If PERT could do no more than . . . provide our operating people with an effective tool for improvement of their own performance, it would have been abundantly worth the effort we have put into it," Codier told the AMA seminar.

"But once a PERT plan has been formulated, there is now available a well-organized and extremely 'visible' plan which can be used for management purposes. There is available a tool with which we can improve the quality of our quotations in terms of both price and delivery. We can have these quotations backed up not only with the knowledge that they are realistic and attainable, but also with a detailed plan of how to go about accomplishing our promises," Codier said.

However, he warned that PERT is not a substitute for intelligent professional behavior by all parties involved in "massive engineering projects." PERT offers the possibilities of "administrative spying" and Codier said that management must resist the temptation to use it for this purpose.

Codier said that GE has found it moderately easy to sell its engineers and other operating personnel on the merits of PERT. One reason is that the basic technique is familiar to the engineer because it is used in engineering problem analysis. Even more important, "PERT is unique in its capability for properly considering, recognizing and providing assistance with the most important problem in massive engineering projects—uncertainty."

The uncertainties in massive engineering defense projects are compounded by the fact that invention must be accomplished on schedule, even though it inherently defies scheduling, and production must follow right on the heels of invention instead of lagging five to 10 years behind the state of the art as with most other types of products.

Codier described the sort of "gamesmanship" that occurred in obtaining delivery estimates before the introduction of PERT, and its consequences, with the admission that the description was only a slight exaggeration.

A manager picks up the phone "and with casual and disarming friendliness asks the engineer: 'Say, George, just off the top of your head, how long would it take to get out 14 frabastats?' Although the engineer knows that it should take eight weeks, providing everything goes well, he first adds two weeks to cover unforeseen difficulties, but the padding doesn't end here.

"George is not misled by the informality of the request. He knows that ultimately his estimate will show up as a commitment. And because time estimates traditionally are too long, he can expect to be asked to cut his estimate. So he adds another three weeks and quotes 13 weeks for delivery."

When the 13-week estimate proves to be too long, as it invariably does since it is in fact too long, the manager asks for extra effort to cut delivery to 11 weeks. The manager figures he has done pretty well because the engineer makes the customary grumbling noises.

"All the manager has at this point is a commitment. He has no measure of potential trouble sources which he might be able to smooth out if he were only aware of them. If the engineer delivers the 14 frabastats in 11 weeks, the manager does not know whether this was an outstanding effort or merely average performance," Codier said.

If the devices are intended for a crash program, the manager may insist that the engineer cut the quoted delivery scheduled to seven weeks—a technique known as "setting a challenging goal." Despite the engineer's protestations, he works extra hard and ends up delivering the frabastats in nine weeks.

At this point, Codier said, the manager faces a "Hobson's choice": The engineer has bettered his original estimate by four weeks, suggesting that he did an outstanding job for which he should be commended. But he has fallen two weeks behind the customer-stated and manager-dictated delivery schedule so that a commendation implies approval of "late delivery."

The use of PERT encourages intellectual honesty on the part of all members of an industrial team, from management to working level engineer. When Light Military Electronics Dept. gets ready to bid on a new job, the group that will carry out the work gets together with a member of the Engineering Resources Planning & Analysis group which Codier heads. This program planner acts as a combination leader and "devil's advocate."

The group first develops a design plan which involves little or no technical risk, using current state of the art. A PERT network is then prepared, and the program planner proceeds in random manner to ask for time estimates for each major milestone.

"Our technical people are sharp enough to calculate and add up expected times in their heads and will see the 'critical path' forming as they go. Experience has shown that there is a tendency to estimate low when the activity is known to be on the critical path. The [random] skipping around is a procedure designed to isolate the estimator from any influence that would tend to cloud his technical judgment," Codier said.

The engineers are first asked to give their optimistic time-estimate, followed by the pessimistic estimate and finally the most likely time to accomplish. "At this point we have a good time estimate, plus some information we never had before—a measure of the uncertainty involved," Codier said. The way in which the three times are distributed is very revealing and helps to identify the nature of the problems.

In today's market, Codier said, a no-risk program usually is too long and the first-cut plan must be shortened to meet the customer's stated requirements or the marketing group's estimate of what is needed to beat out competition. To squeeze down the first-cut plan timetable, there are several possible courses:

• **Overtime:** With PERT, it is possible to see where overtime effort can most effectively be applied to shorten the over-all schedule, instead of wastefully applying it across the board.

• **Elimination:** Certain portions of the first-cut planned work may be eliminnated. For example, in the design of a digital computer, the breadboard construction may be bypassed and the decision made to go directly from logic diagrams to prototype hardware.

• **Parallel efforts:** Activities which normally would be carried out in series may be scheduled for accomplishment in parallel. For example, work may be started on detail drawings before equipment design has been frozen and environmental testing completed.

The first level of project managers usually is involved in the PERT network replanning session because it involves their accountability for resources and risk. Usually one session is enough, but the process can be repeated until the program has been tightened sufficiently, or proved not feasible in the required time scale.

When the program gets under way, and slippage occurs from the original schedule, the program planner first goes to the responsible project engineer to discuss possible corrective action. The action recommended by the project engineer, with the revised time-estimate, is then figured into the network and the over-all effect is calculated. Only at this point is higher management advised of the situation: the problem, the proposed remedial actions and their consequences.

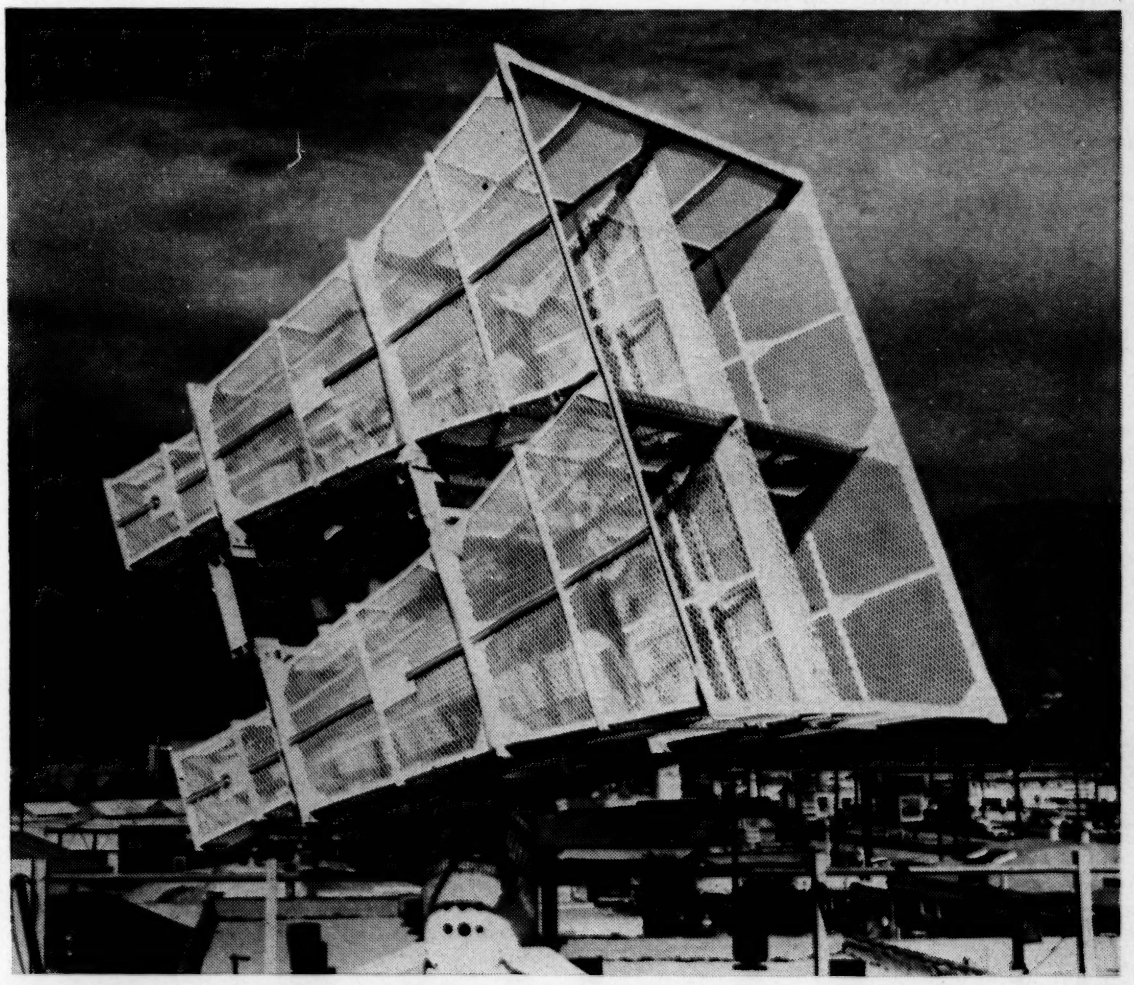
Analysis of the problem may show that the individual engineer has reached the limits of his authority and that the solution lies outside these boundaries. For example, he may require additional resources or assistance from another functional area. This requires action by higher management, a fact pointed out by the PERT network. GE's experience with PERT suggests several important rules for its application, Codier said:

• **Recognition of the real commitment:** The only real commitment is the one made to the customer; all others within the PERT network should be recognized as flexible providing they do not alter the customer commitment.

• **A time estimate** is not a commitment: The PERT time-estimate is the means by which operating level personnel indicate their best technical appraisal of a situation. Once operating level personnel recognize this, it is far easier to obtain estimates and these will be far more accurate than the single-commitment type estimate required before the advent of PERT.

• **Time estimates should not be changed** to shorten over-all program time schedule. If over-all time is to be cut, time must be bought with money, with risk, or by removing "chrome-plated" features from the program. "It is a fundamental rule in our PERT operations," Codier said, "that we will not change a time-estimate on an activity unless there is a significant change in the circumstances or requirements of that activity."

• **PERT program planners should** be experienced engineer-designers. This enables them to speak the same language as the technical project people, and often to contribute to the project plan by drawing on their own experience.



UHF Antenna to Be Used in Secor Experiment

Multi-purpose UHF automatic tracking antenna will be employed as part of geodetic Secor (Sequential Collation of Range) experiment to be conducted in conjunction with the forthcoming Transit IIIB navigation satellite. Antenna radiating systems including associated components and antenna structure were developed by Electronic Specialty Co., Los Angeles, in conjunction with Temec, Inc., a subsidiary of Cubic Corp., which provided pedestal and control system. System, exclusive of pedestal, weighs 650 lb., can handle two kilowatts of CW power at a frequency in the 450-mc. band, can receive in 450- and 225-mc. bands and provide error signals for automatic tracking in both azimuth and elevation. Secor equipment development is being handled by Cubic Corp. under contract to Army Map Service.

Novel Semiconductor Transducer Produces Microwave Ultrasonics

New York – Novel semiconductor transducer which can generate ultrasonic energy at microwave frequencies has been developed by Bell Telephone Laboratories. The new device also can be used to convert acoustical energy into electrical energy.

One important application of the new principle will be in ultrasonic delay lines for computers where the high operating frequency and wide bandwidth will permit storage of large amounts of data. New transducer also will find use in studying acoustical properties of materials at very high ultrasonic frequencies.

First details on the new semiconductor ultrasonic transducer were disclosed at the recent Institute of Radio Engineers convention here by BTL's Donald L. White. He reported that theory indicates that these transducers can produce ultrasonic energy at frequencies ranging from 300 mc. to more than 10,000 mc. Experimental units built to date have been operated at approximately 530 mc. and 830 mc.

In a conventional ultrasonic transducer, a piezoelectric crystal excited from an alternating current source vibrates like a diaphragm to generate ultrasonic waves. The thickness of the crystal determines its natural frequency and therefore establishes the frequency of the generated waves. Fabrication difficulties limit the minimum obtainable crystal thickness and therefore limit the highest frequencies that can be generated.

In the new BTL device, a "depletion layer" formed in a semiconductor with piezoelectric properties serves as the vibrating diaphragm. It can be created with thicknesses as small as 0.01 to 0.0001 cm., corresponding to natural frequencies of 300 mc. to 30,000 mc. The depletion layer is a thin region of high resistivity that occurs at the interface of two dissimilar materials, such as a P-N semiconductor junction or at a rectifying metal-to-semiconductor contact. The thickness, and hence its natural frequency, depends upon the amount of impurity doping and the magnitude of a bias voltage applied across the layer.

Silicon and germanium, widely used semiconductors for transistors, do not have the required piezoelectric characteristics, but there are a number of compounds which do. These include gallium arsenide, cubic zinc sulfide, and hexagonal forms of zinc sulfide, zinc oxide and cadmium sulfide.

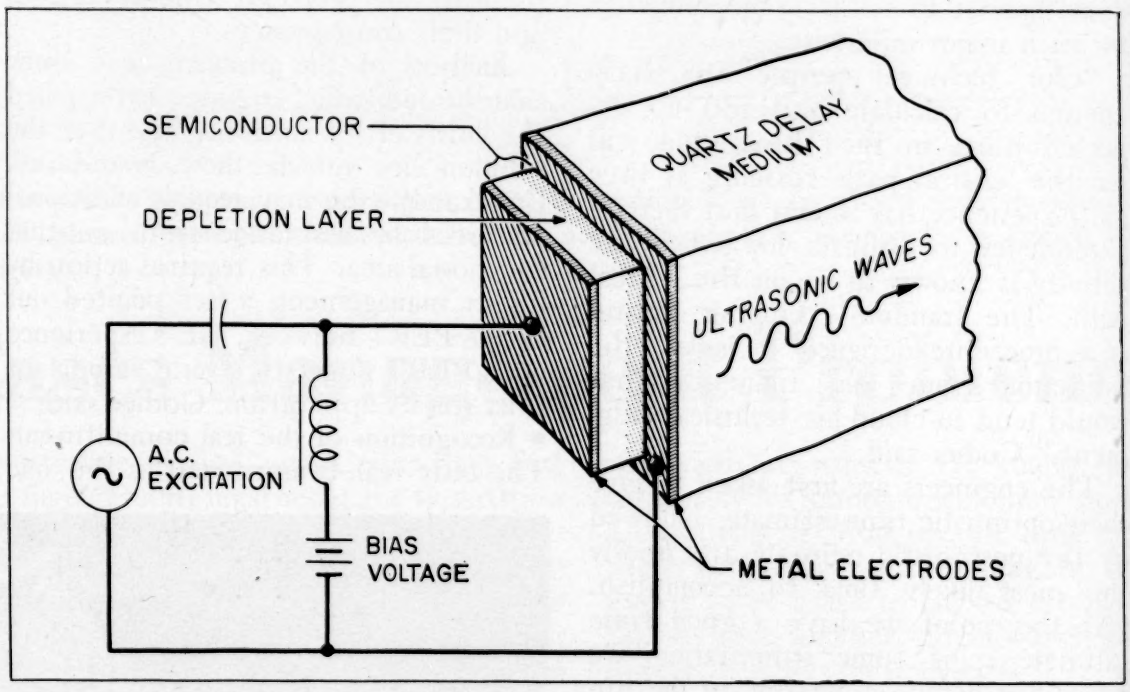
A delay line employing the new principle consists of a quartz rod with two gallium arsenide crystal blocks attached at either end. Along the surface of each crystal where it joins the quartz rod there is a rectifying metal film contact. The opposite surfaces of each crystal have thin ohmic (non-rectifying) gold film contacts. (See sketch.)

A d.c. bias voltage is applied across the two contacts of one crystal and an a.c. voltage is superimposed upon it, as shown in the sketch. The depletion layer produced by the bias voltage is set to vibrating by the a.c. voltage, generating ultrasonic waves which pass down through the quartz rod.

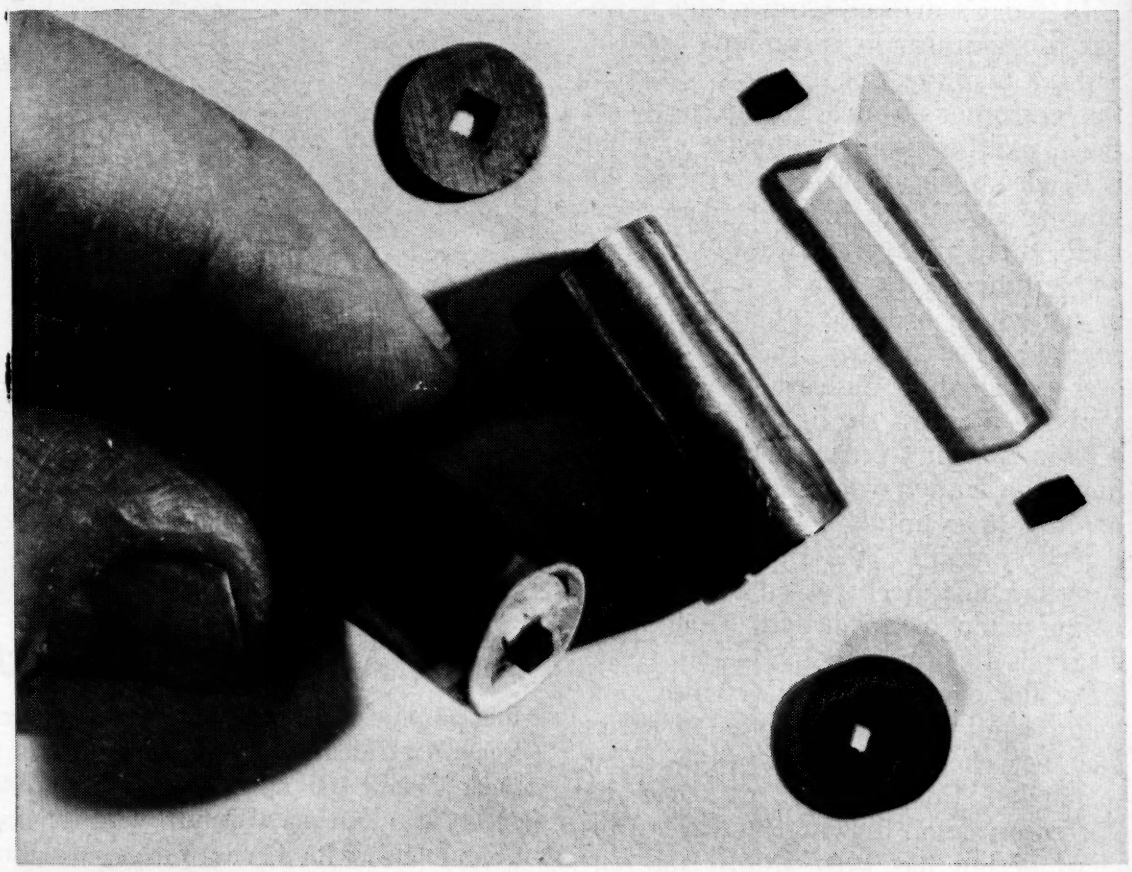
At the opposite end, these ultrasonic waves cause the depletion layer of the second crystal, also biased for the same resonant frequency, to vibrate, which produces an a.c. voltage across its output terminals.

The resonant frequency of a given transducer can be changed by a factor of 3:1, or more, by altering the d.c. bias voltage, White told the IRE.

Because the depletion layer is so thin, it is inherently a low-impedance device, White pointed out. For example, the



NOVEL ultrasonic transducer, capable of generating ultrasonic waves at microwave frequencies, has been developed by Bell Telephone Laboratories. Device uses piezoelectric semiconductor material depletion layer instead of conventional ceramic crystal. Bias voltage determines depletion layer thickness which controls output frequency.



EXPLODED view of experimental ultrasonic delay line which operates at microwave frequencies, showing gallium arsenide crystals (black blocks) which form heart of new type ultrasonic transducer which can generate and reconvert waves at frequencies from 300 mc. to more than 10,000 mc. Development was reported by Bell Labs.

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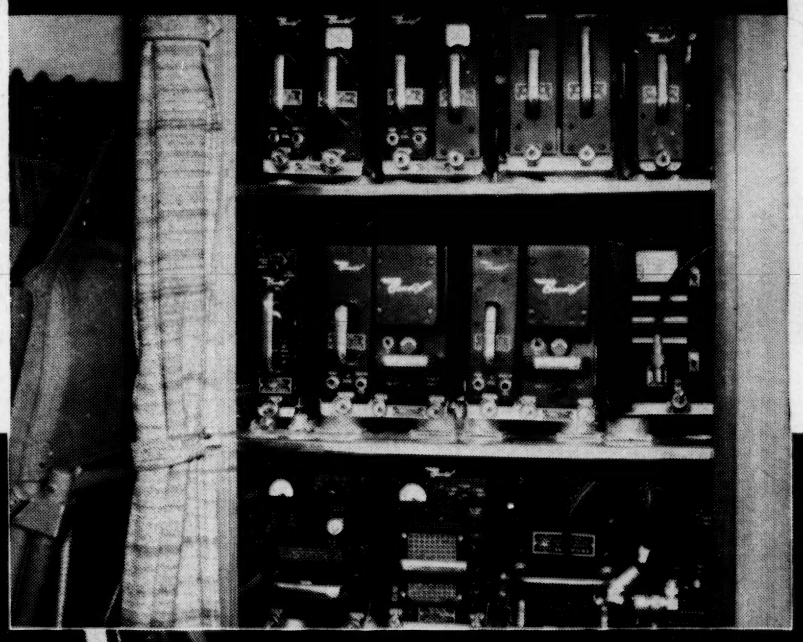

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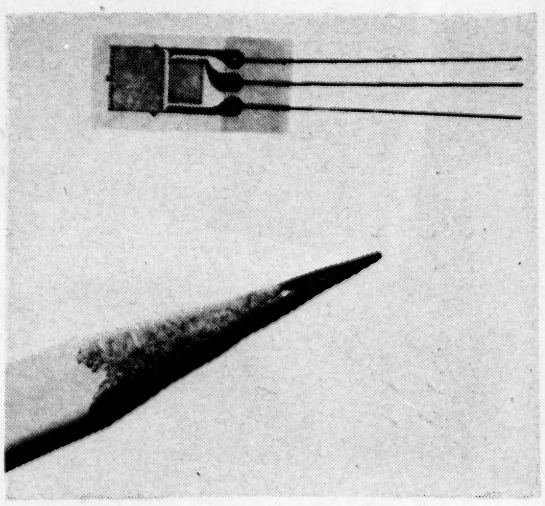
impedance due to the capacitance of a two-millimeter square transducer operating at resonance at 100 mc. is about 0.5 ohms.

For most efficient transfer of energy from a.c. excitation source to ultrasonic energy, it is desirable that the semiconductor material have a low resistance and that the source have a high "Q." As impedance mismatch between source and transducer increases, more of the energy will be dissipated as heat within the transducer.

Where the impedance match is good, the bandwidth of the transducer depends primarily upon the piezoelectric coupling factor of the semiconductor material used in the transducer. Gallium arsenide yields a bandwidth of about 5%, while cadmium sulfide offers a bandwidth of about 20%, because of its greater coupling factor. However, gallium arsenide has a lower resistance, a desirable attribute for impedance match. Thus the choice of material will depend upon the application.

Experimental BTL models using gallium arsenide, which operate at about 600 mc., exhibit bandwidths of about 30 mc. (5%), an order of magnitude larger than conventional ceramic transducers operating at frequencies below 10 mc. Even greater bandwidths should be obtainable at higher operating frequencies, permitting a considerable increase in data-handling capability of a delay line.

Experimental units fabricated today have not shown the very high frequency which theory predicts, White said. However, he added that this is believed due to lack of experience in circuit and fabrication techniques.

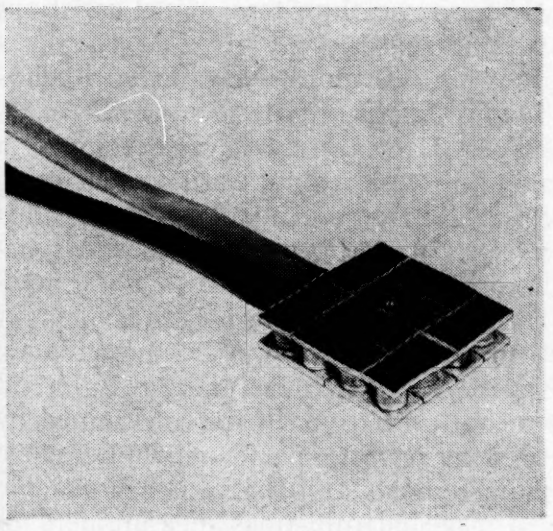


Stress-Strain Gage

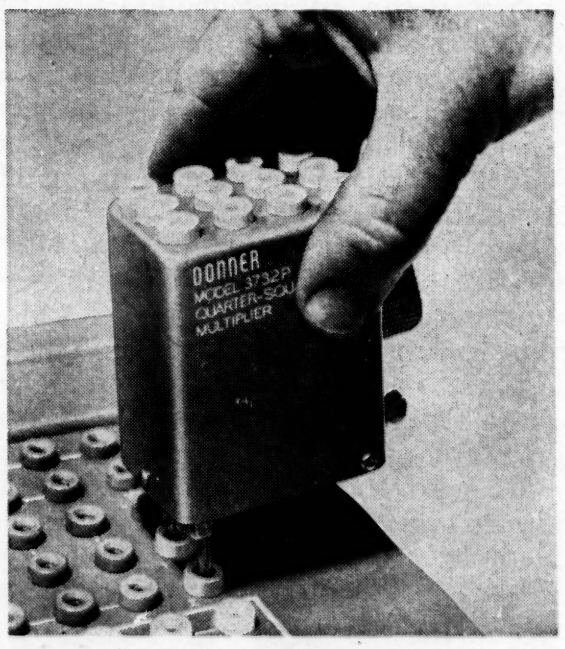
Novel stress-strain gage can provide output which is directly proportional to stress as well as to strain. Device uses two independent axial strain-sensing elements, oriented 90 deg. apart, one of which measures conventional strain while the other rejects axial component of strain caused by stress in transverse direction. Manufacturer: Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.

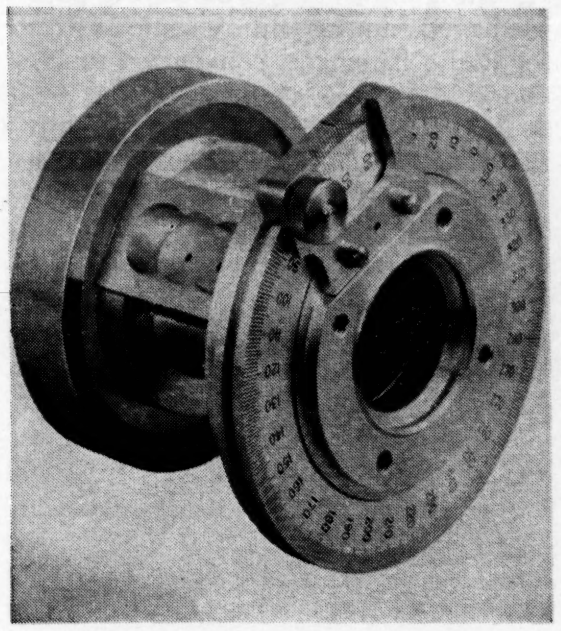
NEW AVIONIC PRODUCTS

• **Thermoelectric spot cooler,** Model TA-20, for spot-cooling of high temperature elements in an avionics chassis, can pump more than 20 watts of heat or maintain temperature differential of 80C between hot and cold plates, according to manufacturer. Thermoelectric cooler measures 1½ x 1½ x ½ in. Even greater capacities can be obtained by connecting several modules in series or parallel. Manufacturer: Ohio Semiconductors, 1205 Chesapeake Ave., Columbus 12, Ohio.

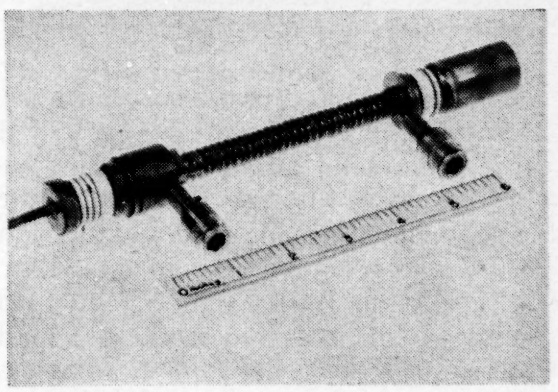


• **Plug-in electronic multiplier,** Model 3732, using all solid-state design, can be plugged into any analog computer problem board with ¾ in. terminal spacing. This includes all computers made by Donner Scientific, Heath, Boeing and Goodyear. Multiplier offers three selectable modes of operation: four-quadrant multiplication with static accuracy of 0.3% of full scale voltage, two-quadrant division, or two-channel squaring. Standard case size is 3 x 2½ x 2 in., but unit also is available for panel or chassis mounting. Manufacturer: Donner Scientific Co., Concord, Calif.





• **Circular waveguide rotating section,** Model 55R5C, for continuous 360-degree rotation of probe for measuring electrical field mode orientation, is designed for operation over frequency range of 3.95 to 18.0 kmc. Operating band width is 5.0 to 5.9 kmc., and residual VSWR is 1.02:1, according to manufacturer: Applied Microwave Electronics Inc., 114 West 25th St., Baltimore 18, Md.



• **Miniature traveling wave tube,** Model STX-182, produces up to 40 watts output over frequency ranges as high as 5 kmc. to 11 kmc., with an internal gain of 3,000, according to manufacturer. Tube measures 9 in. long and weighs 1 lb. Tests on experimental model indicate tube may have a life of more than two years under continuous operation in space environment. Manufacturer: Sperry Gyroscope Co., Electronic Tube Div., Great Neck, L. I., N. Y.

• **Microminiature glass diodes,** known as MICRO/G diodes, with package diameter of 0.04 in. and length of 0.06 in., employ diffused silicon mesa construction with oxide passivation of the surfaces in addition to the glass hermetic seal. Type TI-2 has reverse recovery time of 10 nanoseconds; Type TI-6 has reverse recovery time of 100 nanoseconds. Manufacturer: Texas Instruments, Dallas, Texas.

• **Gallium arsenide varactor,** for use as a preamplifier in radar systems, provides low-noise microwave amplification. Device has cut-off frequency of 150 kmc., measures ¼ in. dia. x ⅛ in. long. Application details available from manufacturer: Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass.

• **Dual-mode transmission discriminator** cavity, Type WX-4334, operating at frequency of 35 kmc., for use with parametric amplifier pumps, navigation systems and radar beacons requiring highly stable frequency source, is housed in a 0.9 in. cube and weighs 3.1 oz. Cavity is vacuum sealed and uses invar construction to minimize resonant frequency change with temperature, which manufacturer says is only 8 mc. over temperature range of 25C to 100C. Each output has a loaded "Q" of 3,000 and a frequency difference between outputs of 10 mc. Insertion loss is 10 db. maximum and insertion loss difference between outputs is one db. maximum. Manufacturer: Westinghouse Electric Corp., Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

• **Precision angle position indicator,** Type KT427566, designed primarily for use in automatic checkout and military field test equipment, is available in six different models for measuring angles to within 6 minutes of arc. Device provides direct readout in degrees and minutes, with sensitivity of 1 min., repeatability of 2 min. and resolution of 1 min., according to manufacturer. Device meets MIL-D-8512, according to manufacturer and is available with either vacuum tube or transistorized amplifier. Manufacturer: Kearfott Division, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

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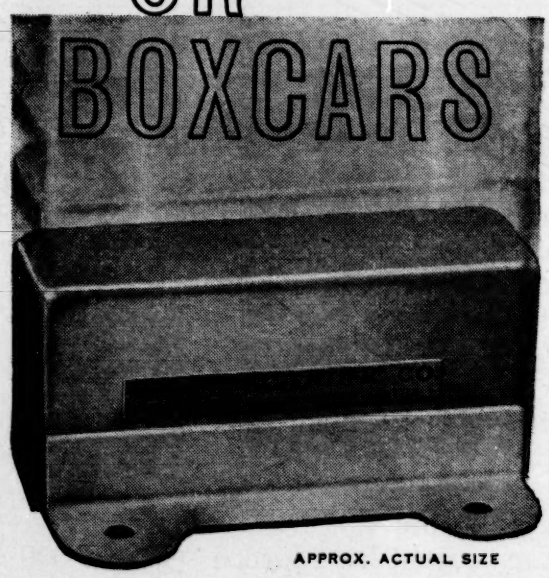

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FILTER CENTER

The following are based on papers delivered during the recent Institute of Radio Engineers convention in New York:

▶ **Pulsed Radiation Effects Report**—Effect of brief pulses of nuclear radiation on resistors depends primarily on the resistance value, dose and dose rate rather than the composition of the resistor, according to tests conducted at the Godiva facility at Los Alamos Laboratories last year, and reported by Dr. H. J. Degenhart and Walter Schlosser of Army Signal Research and Development Laboratories. Resistors of 100 ohms underwent a 10-25% increase while 10,000-ohm resistors experienced only a 1-2% increase after an initial decrease of 5%. Resistors of 100,000 ohms had a 10-30% decrease followed by increases up to 10% over initial value, while one megohm resistors experienced 30-50% decreases. Most of the resistors return to original tolerance limits within 1-2 milliseconds after radiation pulse, although higher resistance units required 5-10 ms. (AW Aug. 8, p. 58).

▶ **Earth-Based System for Lunar Landing**—New technique for controlling the terminal phase of a lunar landing in which bulk of the equipment would be earth-based, was described by Frank R. Dickey, Jr. of General Electric, Syracuse, N. Y. An earth-based continuous-wave microwave transmitter aimed at the moon could produce direct and reflected waves in the vicinity of the moon which would combine to form an irregular standing wave pattern, Dickey said. Lunar vehicle, equipped with two antennas and receivers, would measure interval between time when two antennas encountered the same field gradient to determine vehicle velocity.

▶ **New Ionospheric Scatter Mode Reported**—Existence of what appears to be a new type of scatter communications associated with specular reflection from ionization aligned with the earth's magnetic field has been disclosed by recent experiments conducted by Smyth Research Associates under Rome Air Development Center sponsorship. The new scatter mode has a diurnal cycle which closely resembles that of meteor bursts, but has a higher duty cycle, Byron Bailin of RADC reported. (Paper was co-authored by James L. Heritage of Smyth Research Associates.)

Duty cycle of the new scatter increases as operating frequency decreases, Bailin said.

▶ **Knife-Edge Useful for Tropo Scatter**—The knife-edge diffraction produced by an obstacle such as a mountain, located between a radio transmitter and a receiver, can be used to good advantage in tropospheric scatter communications links, National Bureau of Standards experiments indicate. Paper by A. P. Barsis and R. S. Kirby, both of NBS Boulder (Colo.) Laboratories, reported the results of tests conducted over a 140-mi. path, and using Pike's Peak as the obstacle, to determine long- and short-term variations in obstacle gain. Tests revealed relatively slow fades at a frequency of 751 mc., lasting from several to many minutes, which were well correlated as received on spaced antennas.

A more rapid fading of very much smaller amplitude was superimposed on the slow fade. At a frequency of 100 mc., no short-term signal variations were found.

▶ **Army Develops New Type Radar**—Army Signal Research and Development Laboratories have developed a continuous-wave correlation radar using pseudo-random modulation intended to get around two limitations of conventional pulse-type radar. These limitations are that the average radar power can be increased only by increasing peak power because pulse width and repetition frequency are constrained by desired resolution and maximum range requirements and that it is not possible to make unambiguous measurement of Doppler frequencies higher than one-half the pulse repetition frequency. In the new Army radar, range and velocity information is obtained with phase modulation by changing transmitter frequency for a short time during which the phase of the transmitted signal is shifted 180 deg. Returned echos are correlated with a delay replica of the modulating signal, O. E. Rittenbach and Walter Fishbein of USASRDL reported.

The transmitter output tube also serves as the local oscillator. Experimental results to date closely verify the theory of operation, the authors reported at the convention.

▶ **New Antenna for Monopulse Radar**—New design of monopulse radar antenna which optimizes both the ranging (sum) mode and the angle tracking (difference) mode simultaneously, largely eliminating the low gain and high sidelobes usually found in the difference channel was described by P. W. Hannan and P. A. Loth of Wheeler Laboratories of Smithtown, N. Y. New antenna uses four stacked horns, excited by a simple network of hybrid junctions, to provide a 2:1 difference-to-sum width of feed aperture excitation. In the other plane, three waveguide modes are used to achieve optimization without presence of E-plane partitions which normally reduce efficiency of monopulse feed, Institute of Radio Engineers was told.

Marines Using Helicopter Ditching Trainer

By Barry Tully

Helicopter ditching trainer, comparable in purpose to the World War II "Dilbert Dunker" aircraft ditching trainer, is under evaluation by the Marine Corps at Camp Pendleton, Pa.

The Marine Corps, heavily engaged in amphibious helicopter assault training, realizes a need for training both crews and helicopter assault troops to cope with emergency water landings.

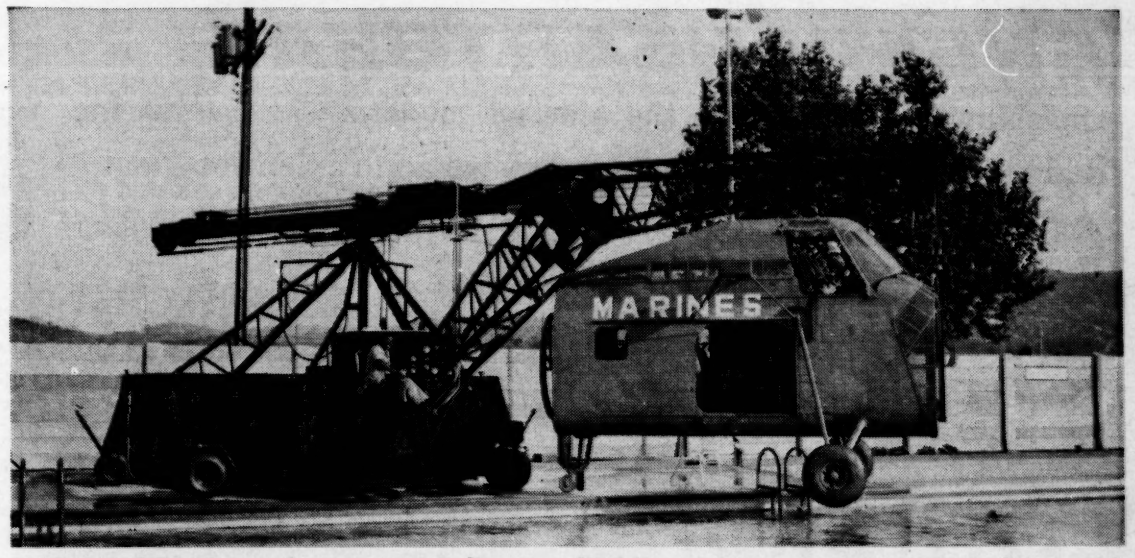
Helicopters, unlike many fixed-wing aircraft, sink rapidly when ditched and tend to heel over due to the high center of gravity. The uncertain ditching characteristics demand that troops and crewmen must practice emergency egress from the trainer while it is in various settling positions. The possibility of the door (right) side of helicopter bottoming in the mud necessitates training in escape through windows.

The trainer was designed and built for the Marines by the Kellett Aircraft Corp., Willow Grove, Pa., in cooperation with the Naval Training Device Center, Pt. Washington, N. Y. The device consists of a mockup of a Sikorsky HUS-1 fuselage which is suspended over a training tank. The interior of the trainer contains seats and safety belts for eight troops and pilot and copilot.

The trainer is loaded with Marines at the side of the pool and then raised and swung out over the water. Hydraulic winches lower the mockup into the water at a vertical speed of 5 fps. The trainer operator can cause the trainer to sink vertically to a depth of 15 ft. or to roll up to 180 deg. to either side. The helicopter crew, with full combat equipment, must escape from the trainer within 20 sec.

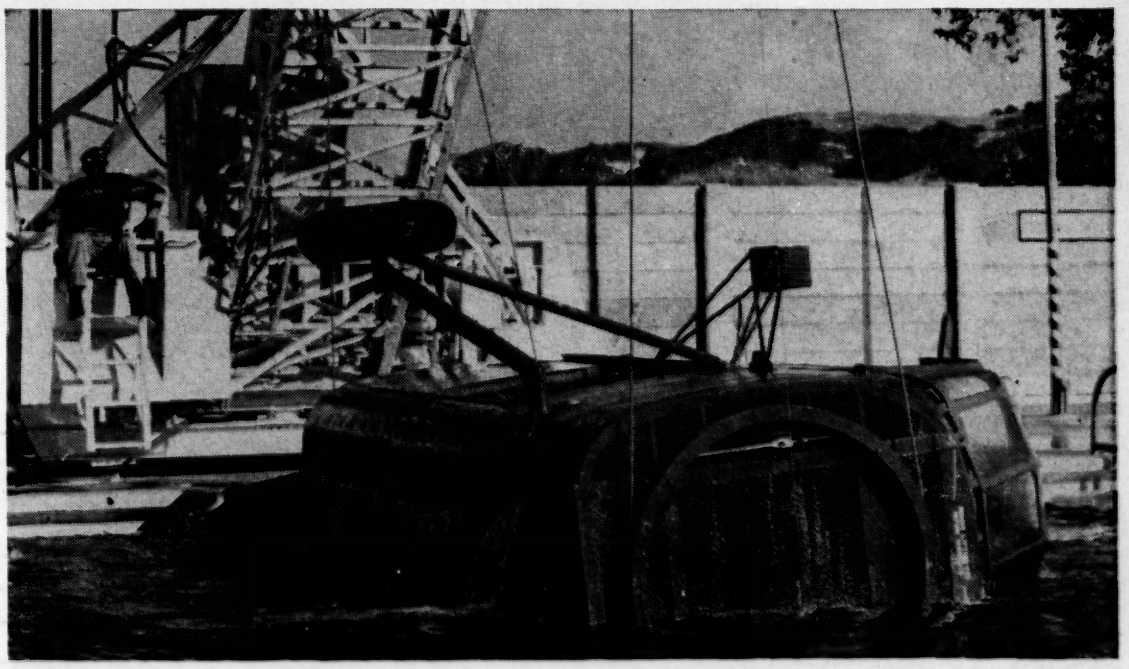
Emergency controls within the trainer permit occupants to initiate raising the trainer from the water within 10 sec. in the event of an underwater emergency. The trainer operator, however, has a retarding override which he may operate if the quickly-rising fuselage is endangering swimmers.

Primary power for the trainer's 1,500-psi. hydraulic system is supplied by a 15-hp. electric motor. Accumulator pressure within the system frees the trainer from dependence on electrical power. At any time during the operation of the trainer, accumulator pressure will suffice to raise the mockup from the water. An extra safety measure is had by the presence of safety divers on the pool bottom during training.



MARINE CORPS assault troops in helicopter ditching trainer are swung over training tank prior to dunking. Ditching trainer is a Sikorsky HUS-1 mockup.

MARINES, in full combat dress, practice correct method of evacuating the submerged helicopter which can be made to settle in various attitudes.



OPERATOR raises submerged trainer which has capsized to port. Metal grid in the nose and floor of the mockup permit water to drain from the trainer.

ENEMY HEARTBEAT Listening for the enemy, looking for him, smashing him—these are the aims of modern Anti-Submarine Warfare. The ASW concept is always searching for advanced ideas on systems and equipment—an area where Bendix-Pacific excels.

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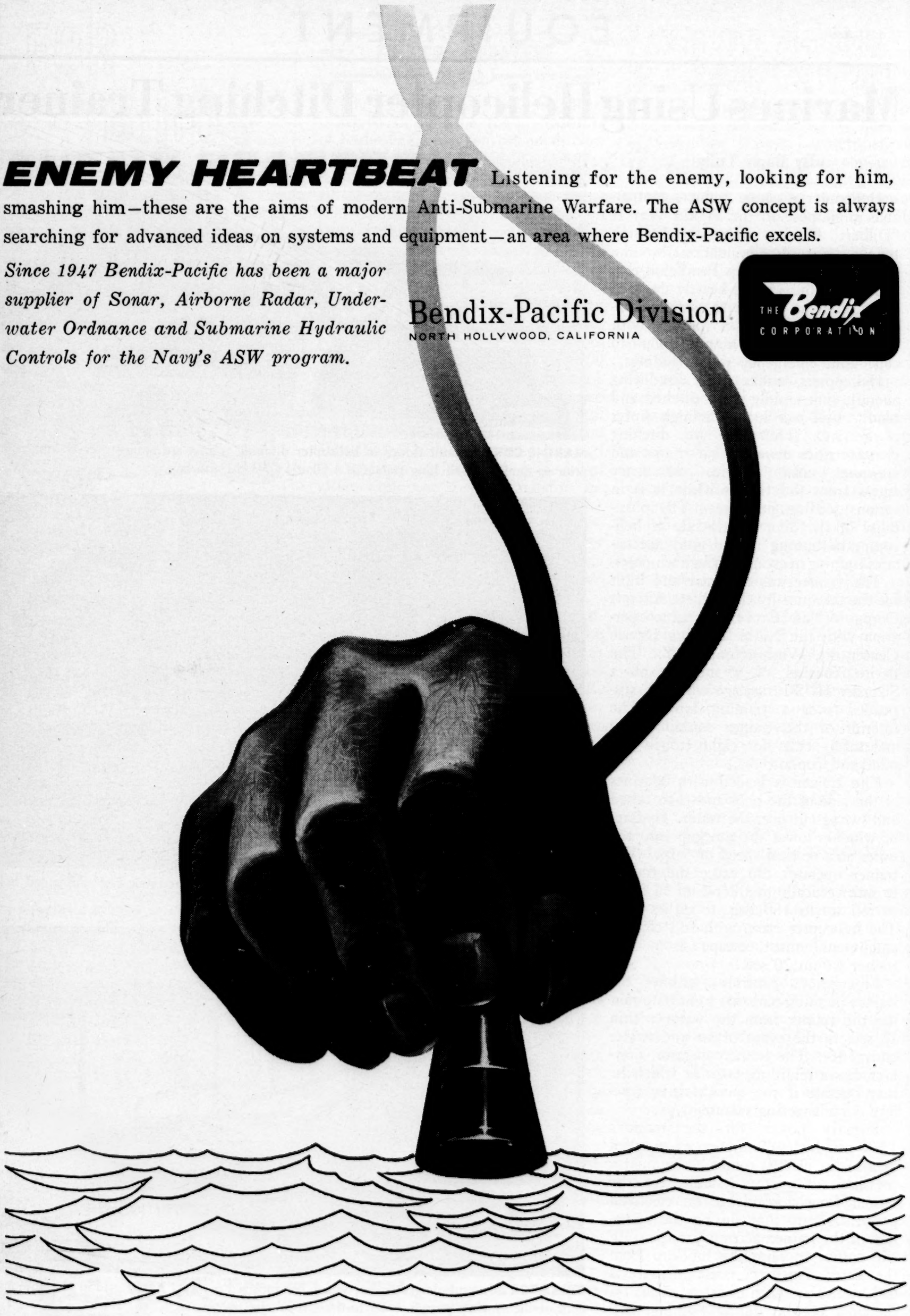


Airborne Jet Analyzer Locates Trouble Spots

Ft. Worth, Tex.—Airborne jet engine analyzer system designed to save maintenance time by pinpointing trouble spots and reducing need for premature engine removals is being tested by the U. S. Air Force on a Boeing B-52 and a Convair F-106.

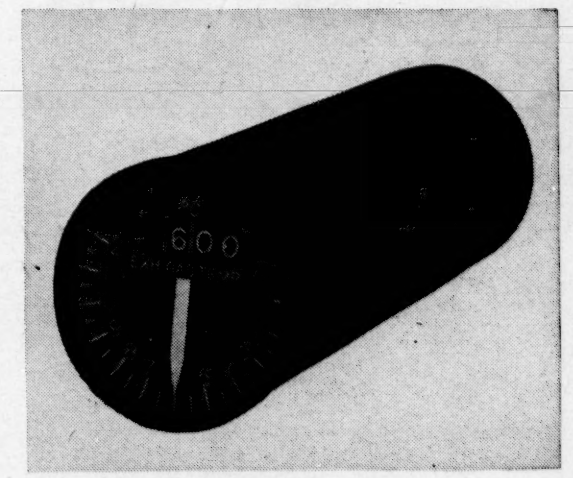
The Howell Instruments, Inc., seven-pound Aero-Jetcal system consists of three basic units:

- **Exhaust gas temperature indicator,** weighing one pound, having digital and pointer readout for readability to 1C with an accuracy of 1C.
- **Engine life remaining** recorder, weighing three pounds.
- **Engine temperature** and excessive temperature spread indicator, weighing three pounds.

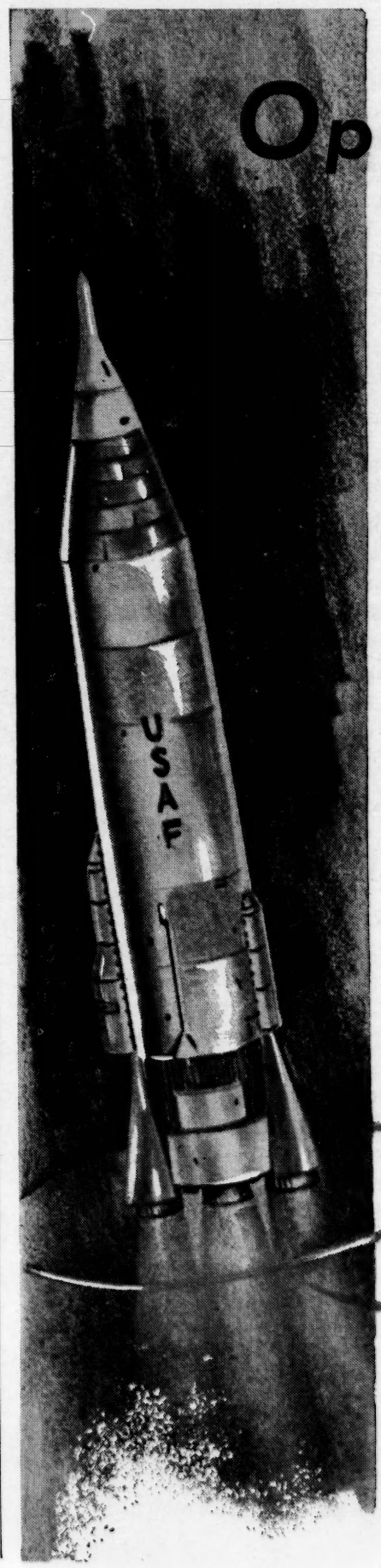
The flight panel-mounted exhaust gas temperature indicator is a transistorized, servo, null-balance instrument in a standard two-inch diameter case, requiring both 115-v. 400 cps. at approximately 10 w., and 28 v.d.c. at less than one watt. Calibrated to the Chromel-Alumel thermocouple curve, the indicator provides digital and pointer readout to 1,200C, maintaining an accuracy of 1C over the entire scale. Accuracy is provided through use of a Howell Ta'Pot as the feedback potentiometer in the servo loop. Ta'pot is an infinite resolution slidewire with the resistance element bonded into one edge of a laminated Mylar tape, the tape being punched with precision holes spaced according to the Chromel-Alumel curve linearized through a sprocket drive to the digital counter readout. Digital counter is calibrated in increments of two degrees from zero to 1,200C. By reading the counters as they revolve, it is possible to read data to one degree, Howell notes.

The temperature-compensated bridge detector compares the input signal with a signal from the feedback potentiometer, and any difference between the two, when amplified and applied to the servo motor, causes the motor to reposition the slidewire until the difference is reduced to zero.

Input signals for the indicator are produced by the averaging thermocouple harness when the indicator is



EXHAUST gas temperature indicator (above) is panel-mounted in cockpit. Exhaust flame propagation (temperature spread) computer (below) scans and compares temperature of thermocouple on jet engine and stores data for instantaneous readout when switch is activated in cockpit.



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monitoring average exhaust gas temperature and by the flame propagation computer when the indicator is monitoring temperature spread.

Mechanical switching is accomplished through the drive mechanism to the digital counter to actuate the warning light on the indicator whenever an over-temperature or overspread condition occurs. This switching device also actuates the excessive-temperature-spread flag and over-temperature events counter on the recorder. As the EGT indicator is monitoring average exhaust temperature, a retransmitting potentiometer geared to the servo motor provides a signal to the engine-life-remaining recorder—this signal being proportional to the amount of engine life being expended at that specific exhaust temperature.

Warning Flag

The engine-life-remaining recorder takes note of the number of over-temperature conditions that have occurred to the engine; a warning flag indicates that the engine experienced excessive temperature spread and it also records the engine life remaining as related to exhaust gas temperature.

As the over-temperature condition is exceeded, a variable-speed motor drives the digital counter on the recorder toward zero at a rate corresponding to the instantaneous over-temperature condition. All engine life expended while operating at over-temperature is cumulatively recorded on one digital counter. The 3-in. x 5-in. x 5½-in. recorder can be placed anywhere in the aircraft convenient to ground maintenance personnel. Its warning flag and digital presentations can only be reset by ground crews.

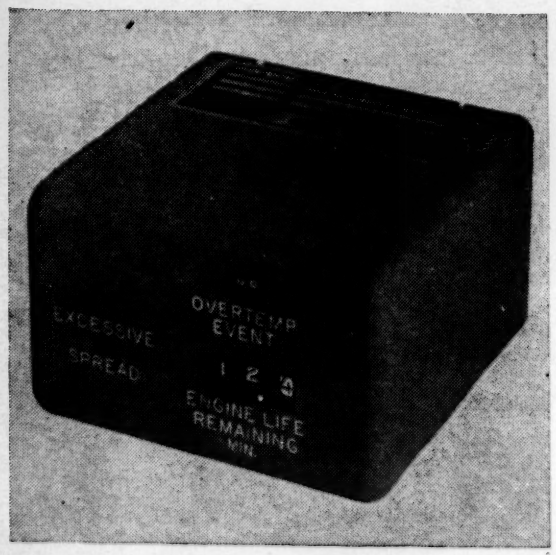
The exhaust flame propagation-temperature spread-computer includes a switching system to scan and compare the temperature of thermocouples in an engine. The temperature of each thermocouple is compared with the other in a continuous sampling sequence using an automatic stepping switch.

On one scanning cycle the thermocouple at the lowest temperature is selected and the memory circuit advances a slave selector switch to that position. On the next scanning cycle, the thermocouple at the highest temperature is selected and the high slave switch is advanced to that position. The difference in the temperatures of the two thermocouples is transmitted to the exhaust gas temperature indicator whenever the temperature spread test switch on the instrument panel is closed by a flight crew member.

While the scanning cycles are continuous and although the exhaust flame propagation changes, the temperature spread signal is stored at all times for instantaneous presentation on the EGT indicator.

When a crew member closes the switch for a check and if the temperature spread is excessive, a warning light appears on the EGT indicator and the excessive-temperature-spread flag on the engine-life-remaining recorder is energized. Releasing the switch results in the EGT indicator monitoring average EGT—the warning light going off—but the warning flag remaining in visible condition for the maintenance crew.

Excessive temperature spreads could indicate a malfunction of fuel supply or in the combustion section of the engine, or possibly a misaligned combustion chamber or guide vane.



ENGINE-life-remaining recorder compiles number of over-temperature conditions that have occurred on engine, and records life remaining, based on jet exhaust gas temperature. Over-temperature causes warning flag to appear in window at left.

Helicopters' Static Shock Hazard Studied

Buffalo—Cornell Aeronautical Laboratory has developed equipment that can take the electrical charge out of a hovering helicopter and protect ground handling crews from serious injury. Static dischargers used on conventional aircraft had proved ineffective for slow-moving helicopters and there are many instances on record of crewmen receiving severe shocks of up to several thousand volts.

The compact and relatively lightweight equipment developed by Cornell allows a pilot to flip a switch and eliminate the electrical "potential difference" between the helicopter and the ground. Preliminary tests using an Army helicopter have been started here but plans are to move the experiments to California where better conditions exist and a greater variety of helicopters is available.

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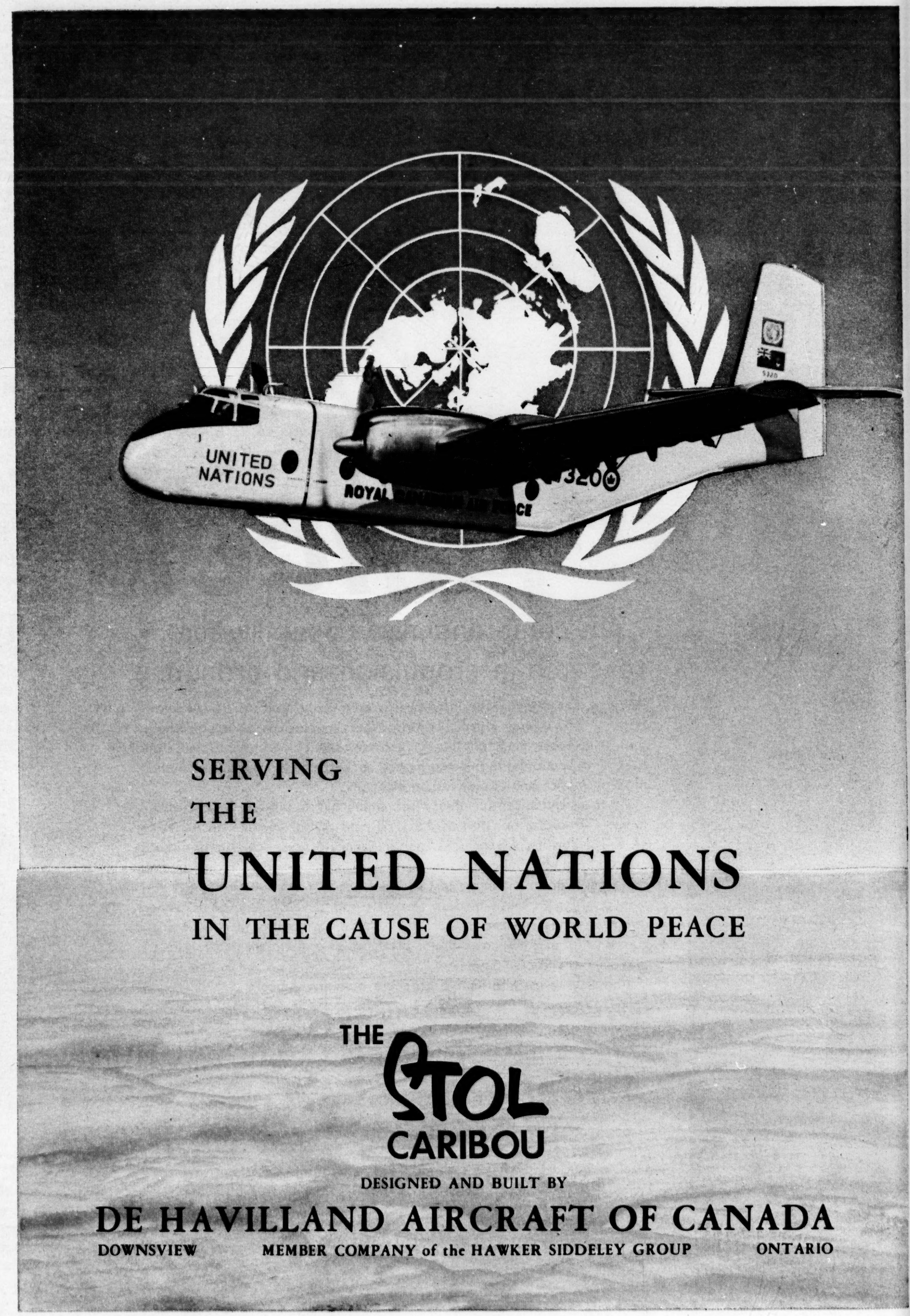

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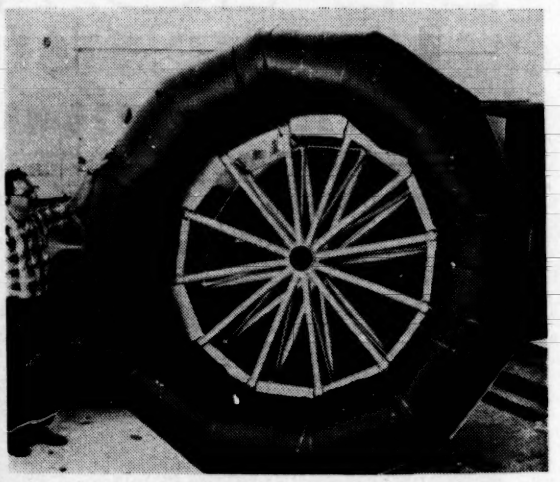
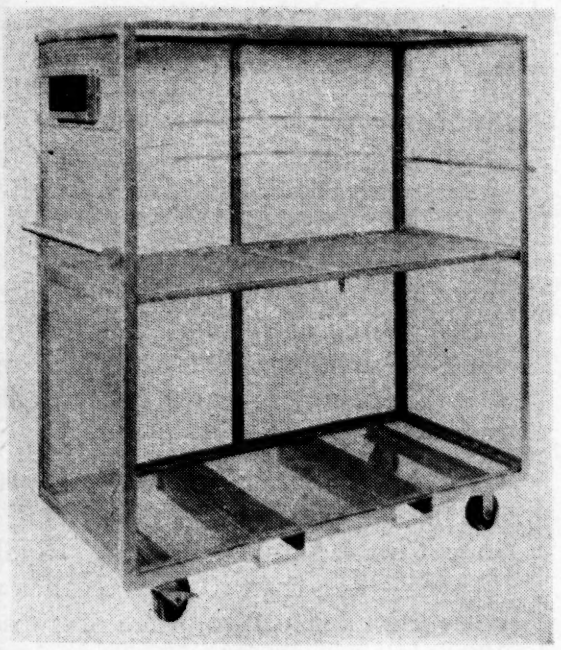


Pneumatic Decelerator

Inflatable fabric ring is designed to stabilize and cushion the landing of space vehicles on the moon or planets.

Test drops made with the pneumatic decelerator by the manufacturer indicate that the device would bring a lunar payload to rest without damage on hard, rocky or sloped surfaces. Upon surface impact, the decelerator is partially deflated to minimize bounce.

Goodyear Aircraft Corp., Litchfield Park, Ariz.



Freight Container

Mercury Air Freight, Inc., is putting into service a freight container designed to expedite the flow of freight in and out of air terminals. The perforated pressed steel container measures 5 ft. x 5 ft. x 28 in. and weighs about 160 lb.

Airline personnel will preload the containers and roll them onto the cartage contractor trucks, thereby cutting down on the time the truck driver spends waiting around the terminal for his truck to be loaded. According to a study that Air Cargo, Inc., made several years ago, truck drivers spend 25% of their time at the airport—much of it waiting for loading. Mercury Air

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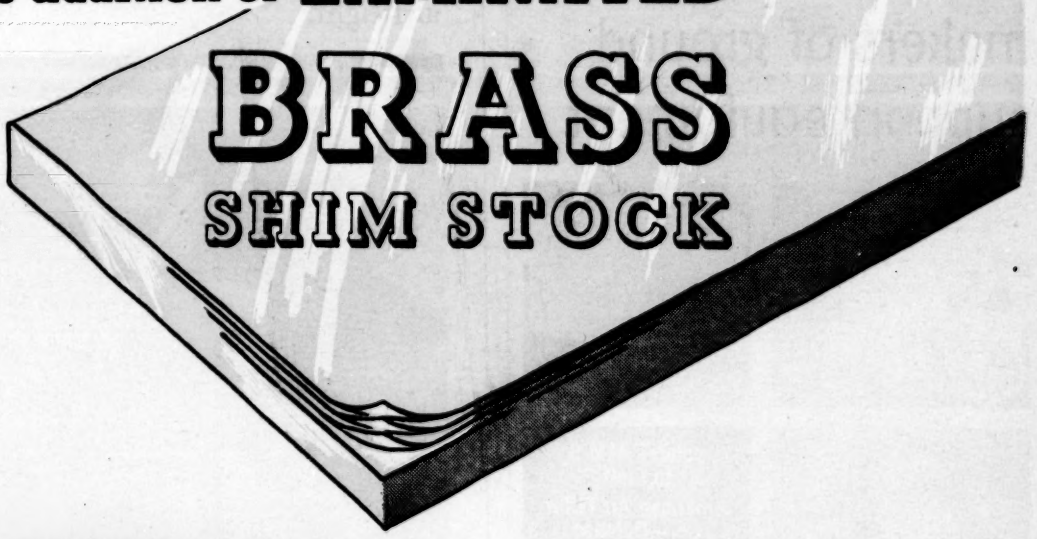

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Barber-Colman temperature controls chosen by leading makers of ground support equipment

Solar T-41M-9, top left
American Air Filter Co.—Defense Products Division C-10, top right
C. G. Hokanson Company—Model 798, left

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Today's air and space vehicles call for a growing array of ground support equipment. Shown above are a few examples of support units employing Barber-Colman temperature control systems. Components used include: control boxes, actuators, valves, temperature sensing elements, and thermostats. The systems are specifically engineered for each application through the teamwork of the ground cart manufacturer and Barber-Colman.

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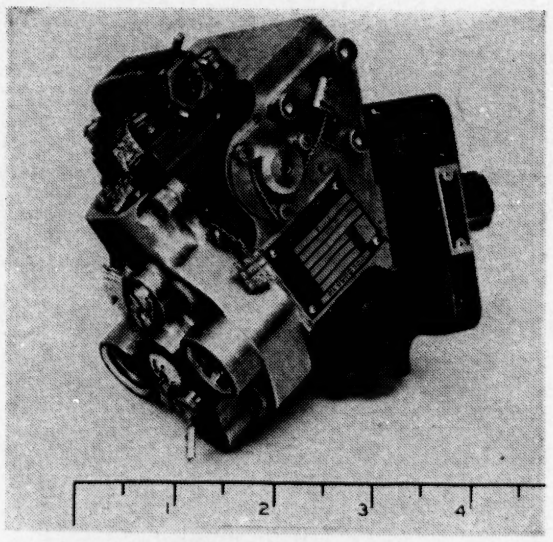
Beryllium shear bolts for space and missile applications have a minimum shear strength of 60,000 psi. and an endurance limit of 45,000 psi.

Light weight of the beryllium bolt is demonstrated by floating the bolt in an aqueous silver nitrate solution (above) in which a comparable titanium bolt sinks.

Standard Pressed Steel Co., Jenkintown, Pa.



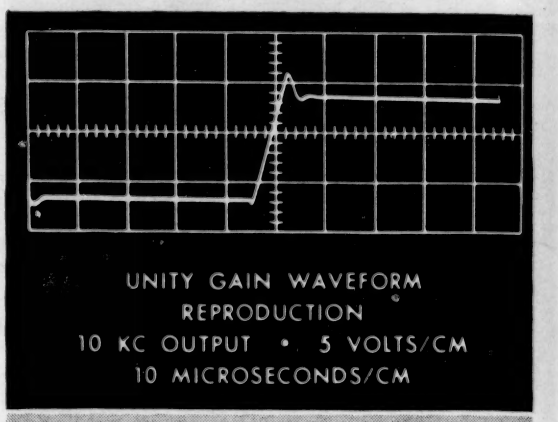
Hydraulic Servo-Motor

Servo-motor package for missile and aircraft control systems, places a rotary motor, servo valve and internal relief valves in one housing.

The servo-motor is available with a range of torque-speed characteristics depending on motor size, servo size, supply pressure and speed reducer size. Breakaway torque is reduced by a factor of 8, compared with a manifolded servo valve motor package.

Aero Hydraulics Division, Vickers, Inc., Detroit 32, Mich.

FAST
ALL SOLID STATE DC AMPLIFIER



HALF USUAL COST

If you have applications requiring a miniature DC amplifier with *fast* frequency response, there's a good chance RIG's new DIFFERENTIAL OPERATIONAL AMPLIFIER MODEL A-2 can cut your amplifier costs 50% or more. Until now, only far higher priced transistorized amplifiers exhibited rise time characteristics comparable to the A-2. Check *and compare* these specifications:

OPEN LOOP GAIN — 100,000. **GAIN-BANDWIDTH PRODUCT** Short Circuit Stable — 200 KC. **RISE TIME** — Less than 10 microseconds at unity gain, and at gain of ten; less than 100 microseconds at gain of one hundred. **DRIFT REFERRED TO INPUT** — Less than two millivolts over 75°F to 120°F change of ambient; less than 100 microvolts over eight-hour period at constant temperature.

Request RIG-AMP Technical Bulletin for complete details.

ALSO AVAILABLE. Companion, plug-in Power Booster for use with Amplifier A-2 in driving heavy instrument systems, rotary amplifiers, and small DC servos.

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SPECIAL-PURPOSE ANALOG COMPUTERS FOR DATA HANDLING AND CONTROL, ELECTRONIC COMPONENTS, NMR AND ESR SPECTROMETERS, MAGNETIC RESONANCE ANALYTICAL SERVICES

Lockheed Aircraft in Top Position In 1960 Defense Contract Awards

Washington — Lockheed Aircraft Corp. moved into the top position in net value of military prime contracts awarded by Department of Defense in Fiscal 1960, toppling Fiscal 1959's leader, North American Aviation, Inc., to third place.

Lockheed has $666 million worth of contracts, or 12% of the total net value of $5,532 million award to 500 contractors; rankings are for contracts of $10,000 or more. Second place was taken by General Dynamics Corp., with $528 million, moving into that slot from fourth place in Fiscal 1959. Total awards in Fiscal 1959 were $5,246 million (AW Jan. 9, p. 122).

Following is a breakdown of companies, governmental agencies and nonprofit institutions, by rank:

RANK	COMPANY	LOCATION	DOLLARS (thousands)
1.	Lockheed Aircraft Corp.	Burbank, Cal.	$666,306
2.	General Dynamics Corp.	New York, N. Y.	528,057
3.	North American Aviation, Inc.	Los Angeles, Cal.	473,797
4.	General Electric Co.	Schenectady, N. Y.	396,722
5.	Western Electric Co., Inc.	New York, N. Y.	270,306
6.	Martin Co., (The)	Baltimore, Md.	245,799
7.	Boeing Airplane Co.	Seattle, Wash.	205,734
8.	Aerojet-General Corp.	Azusa, Cal.	182,464
9.	Sperry Rand Corp.	New York, N. Y.	120,077
10.	Westinghouse Electric Corp.	Pittsburgh, Pa.	118,448
11.	Douglas Aircraft Co.	Santa Monica, Cal.	100,264
12.	Thiokol Chemical Corp.	Bristol, Pa.	99,355
13.	Radio Corp. of America	Camden, N. J.	91,996
14.	General Motors Corp.	Detroit, Mich.	81,595
15.	Avco Corp.	Stratford, Conn.	80,781
16.	United Aircraft Corp.	East Hartford, Conn.	78,345
17.	Space Technology Laboratories	Los Angeles, Cal.	76,907
18.	International Telephone & Telegraph Corp.	Clifton, N. J.	71,563
19.	Raytheon Co.	Waltham, Mass.	69,473
20.	Bendix Corp.	Detroit, Mich.	61,509
21.	Hughes Aircraft Co.	Culver City, Cal.	60,445
22.	American Bosch Arma Corp.	Garden City, N. Y.	56,031
23.	Goodyear Aircraft Corp.	Akron, Ohio	40,351
24.	Hercules Powder Co.	Wilmington, Del.	36,633
25.	Northrop Corp.	Hawthorne, Cal.	34,621
26.	Temco Aircraft Corp.	Dallas, Tex.	33,184
27.	Thompson Ramo Wooldridge, Inc.	Cleveland, Ohio	33,177
28.	Minneapolis-Honeywell Regulator Co.	Minneapolis, Minn.	27,121
29.	American Machine & Foundry Co.	Buffalo, N. Y.	26,782
30.	Sylvania Electric Products, Inc.	Waltham, Mass.	26,191
31.	Philco Corp.	Philadelphia, Pa.	24,996
32.	Burroughs Corp.	Detroit, Mich.	23,263
33.	International Business Machines Corp.	New York, N. Y.	20,554
34.	Ford Motor Co.	Detroit, Mich.	20,109
35.	Pan American World Airways, Inc.	Buffalo, N. Y.	17,626
36.	Fairchild Engine & Airplane Corp.	Hagerstown, Md.	16,593
37.	Collins Radio Co.	Cedar Rapids, Iowa	16,366
38.	General Tire & Rubber Co.	Akron, Ohio	14,644
39.	Litton Industries, Inc.	Beverly Hills, Cal.	13,882
40.	Marquardt Corp.	Van Nuys, Cal.	12,478
41.	Vitro Corp. of of America	New York, N. Y.	11,907
42.	McDonnell Aircraft Corp.	St. Louis, Mo.	11,398
43.	Cutler-Hammer, Inc.	Milwaukee, Wis.	11,390
44.	Motorola, Inc.	Chicago, Ill.	10,076
45.	Hoffman Electronics Corp.	Los Angeles, Cal.	9,874
46.	Chance Vought Aircraft, Inc.	Dallas, Tex.	9,866
47.	General Precision, Inc.	Binghamton, N. Y.	9,043
48.	Curtiss-Wright Corp.	Wood-Ridge, N. J.	8,905
49.	Fairchild Camera & Instrument Corp.	Syosset, N. Y.	8,831
50.	Land Air, Inc.	San Leandro, Cal.	8,789
51.	Grumman Aircraft Engineering Corp.	Bethpage, N. Y.	8,314
52.	Sanders Associates, Inc.	Nashua, N. H.	8,309
53.	Air Products, Inc.	Allentown, Pa.	7,986
54.	Magnavox Co.	Fort Wayne, Ind.	7,342
55.	Hallicrafters Co.	Chicago, Ill.	7,289
56.	American Radiator & Standard Sanitary Corp.	Union, N. J.	7,095
57.	Little (Arthur D.) Inc.	Cambridge, Mass.	6,655
58.	Acoustica Associates, Inc.	Los Angeles, Cal.	6,272
59.	Melpar, Inc.	Falls Church, Va.	6,271
60.	Hayes Aircraft Corp.	Birmingham, Ala.	6,269
61.	Union Carbide Corp.	New York, N. Y.	6,193
62.	Chrysler Corp.	Detroit, Mich.	6,123
63.	Metal Hydrides, Inc.	Beverly, Mass.	6,006
64.	Atlantic Research Corp.	Alexandria, Va.	5,664
65.	Bell Aircraft Corp.	Buffalo, N. Y.	5,491
66.	Bell Helicopter Corp.	Fort Worth, Tex.	5,224

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Your need for a full margin of reliability in servo systems is matched by the *continuous* quality of G-M Servo Motors and Generators. The extra design experience that goes into every G-M unit is guided through production by test, after test, after qualification test. Sizes range from 5 to 18, with prompt availability that promises quick adaptation to your servo development and production programs.

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TO DESIGN YOUR OWN TIMING SYSTEM WITH EECO'S DO-IT-YOURSELF COMPONENTS

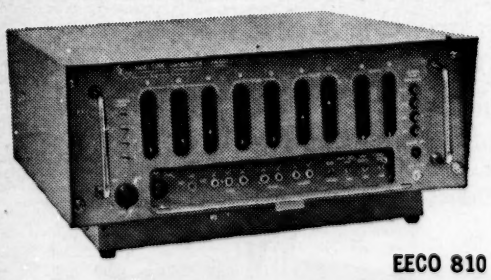
Now instrumentation engineers and test range management can build up their own precision timing systems with the convenience and economy of standardized, compatible, *all solid state,* off-shelf components. All standard time code formats available. Frequency stability, 3 parts in 10^8/day. Every EECO product is realistically priced for tight budgets. Prices include system design consultation by the leading developers of timing and synchronization instrumentation.

TIME CODE GENERATORS

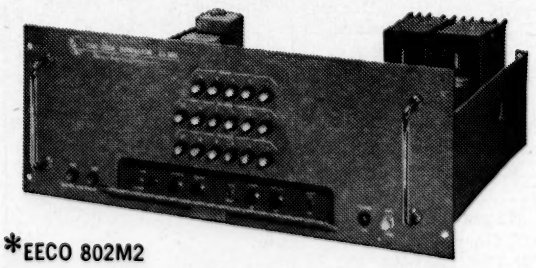
Model Number	Serial Code Format	Time Indication	Code Frame Length (SEC)	Code Scan Rates (PPS)	Code Carrier Frequency (CPS)	Auxiliary Pulse Rates (PPS)	Price (f.o.b. Santa Ana)
EECO 801	24-Bit, 24-hour, BCD	hours, minutes, seconds	1	25, 50, 100	1000	100K, 10K, 1K, 100, 50, 25, 10, 1	$7500
EECO 802 (Eglin AFB and Patrick AFB)	17-Bit, 24-hour, Binary	hours, minutes, seconds	1	20, 100	1000	100K, 10K, 1K, 100, 20, 10, 1	$7000
	13-Bit, 24-hour, Binary	hours, minutes, ¼ minutes	15	1	1000		
* EECO 802M2 (Atlantic Missile Range)	17-Bit, 24-hour, Binary	hours, minutes, seconds	1	20, 100	1000	100K, 10K, 1K, 100, 20, 10, 1	$7000
			20	1			
EECO 803	20-Bit, 24-hour, BCD	hours, minutes, seconds	1	25	250	None	$7500
EECO 804	20-Bit, 24-hour, BCD	hours, minutes, seconds	1	25	100 (mixed with 1000)	1 1ppl0s 1ppm	$7925
EECO 810	36-Bit, 365-day, BCD (4 extra bits available for identification data)	days, hours, minutes, seconds	1	100	1000	None	$10,100
EECO 810M1 (IRIG Member C Format Modified)	23-Bit, 365-day, BCD (4 extra bits available for identification data)	days, hours, minutes, seconds	60	2	1000	10K, 1K, 100 10, 1, 1ppm, 1pphr	$10,100

Model Number		Price (f.o.b. Santa Ana)
EECO 860	**Neon Distribution Amplifier.** Accepts up to 3 pulse-width modulated signals from a time code generator to provide signals to drive camera neon lamps in remote sites.	$2500
EECO 861	**Relay Driver.** Accepts up to seven separate pulse trains or pulse-width modulated codes from a time code generator. Seven separate mercury-wetted relay contact closures to control external equipment.	$1200
EECO 863	**Line Driver** for transmitting 12 channels of carrier modulated timing signals over long distances.	$1975
EECO 27096	**Scanner Unit.** Accepts outputs from the EECO 802M1. Produces two 17-bit modified time-of-day codes in the format of the Atlantic Missile Range and one pulse rate output.	$5775

Compatible automatic magnetic tape search equipment is available for operation with each EECO time code generator.



EECO 810



*EECO 802M2

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Electronic Engineering Company *of California*

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MISSILE & AIRCRAFT RANGE INSTRUMENTATION • DIGITAL DATA PROCESSING SYSTEMS • TIMING SYSTEMS • COMPUTER LANGUAGE TRANSLATORS • SPECIAL ELECTRONIC EQUIPMENT

EE 1-29

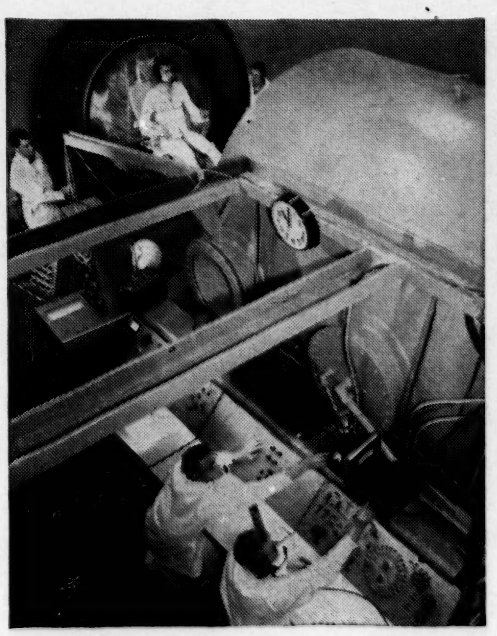
67.	Cook Electric Co.	Chicago, Ill.	5,165
68.	Rheem Manufacturing Co.	Downey, Cal.	5,131
69.	Alpha Corp.	Richardson, Tex.	4,974
70.	A C F Industries, Inc.	Riverdale, Md.	4,970
71.	Loral Electronics Corp.	New York, N. Y.	4,707
72.	Kaman Aircraft Corp.	Bloomfield, Conn.	4,623
73.	General Mills, Inc.	Minneapolis, Minn.	4,520
74.	Callery Chemical Co.	Callery, Pa.	4,463
75.	Rohm and Haas Co.	Huntsville, Ala.	4,309
76.	Gilfillan Brothers, Inc.	Los Angeles, Cal.	4,249
77.	Olin Mathieson Chemical Corp.	New York, N. Y.	4,160
78.	Edo Corp.	College Point, N. Y.	3,903
79.	Varian Associates	Palo Alto, Cal.	3,793
80.	Aircraft Armaments, Inc.	Cockeysville, Md.	3,636
81.	Polytechnic Research & Development Co. Inc.	Brooklyn, N. Y.	3,490
82.	Beech Aircraft Corp.	Wichita, Kansas	3,473
83.	Ryan Aeronautical Co.	San Diego, Cal.	3,397
84.	Cubic Corp.	San Diego, Cal.	3,388
85.	Interstate Electronics Corp.	Anaheim, Cal.	3,257
86.	Maxson (W. L.) Corp.	New York, N. Y.	3,248
87.	Eastman Kodak Co.	Rochester, N. Y.	3,214
88.	Texas Instruments, Inc.	Dallas, Tex.	3,122
89.	Electro-Optical Systems	Pasadena, Cal.	3,058
90.	Control Data Corp.	Minneapolis, Minn.	2,965
91.	Borg-Warner Corp.	Kalamazoo, Mich.	2,913
92.	Autometric Corp.	New York, N. Y.	2,887
93.	Sundstrand Corp.	Rockford, Ill.	2,854
94.	Admiral Corp.	Chicago, Ill.	2,835
95.	Technical Operations, Inc.	Burlington, Mass.	2,822
96.	Food Machinery and Chemical Corp.	San Jose, Cal.	2,811
97.	Ampex Corp.	Redwood City, Cal.	2,758
98.	Coleman Engineering Co., Inc.	Torrance, Cal.	2,679
99	Daystrom, Inc.	Newark, N. J.	2,674
100.	Telecomputing Corp.	Alamogordo, N. M.	2,601
101.	Dow Chemical Co.	Midland, Mich.	2,574
102.	Hazeltine Corp.	Little Neck, N. Y.	2,563
103.	Brown Engineering Co., Inc.	Huntsville, Ala.	2,497
104.	HRB-Singer, Inc.	State College, Pa.	2,296
105.	Radiation, Inc.	Melbourne, Fla.	2,246
106.	Caterpillar Tractor Co.	Peoria, Ill.	2,163
107.	Hughes Tool Co.	Culver City, Cal.	2,157
108.	Belock Instrument Corp.	College Point, N. Y.	2,156
109.	Garrett Corp.	Los Angeles, Cal.	2,155
110.	Lockheed Electronics Co.	Plainfield, N. J.	2,131
111.	Reeves Instrument Corp.	New York, N. Y.	2,095
112.	MinnesotaMining & Manufacturing Co.	St. Paul, Minn.	2,017
113.	Allied Research Associates, Inc.	Boston, Mass.	1,916
114.	Harvey Aluminum, Inc.	Torrance, Cal.	1,852

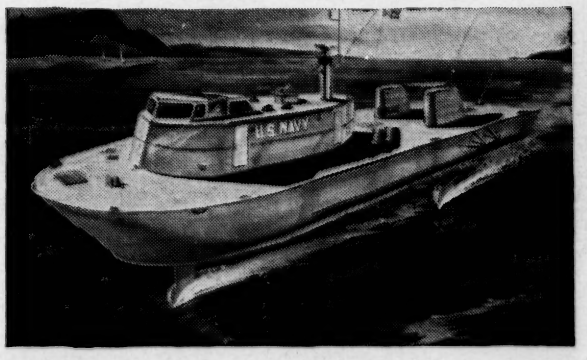
MISSILE BOMBER. New "H" model is latest version of famous Boeing B-52 missile bomber, most versatile long-range weapon system in U.S. Air Force arsenal. B-52H here carries mock-ups of four Skybolt air-launch ballistic missiles. B-52s can also carry supersonic Hound Dog missiles for in-flight launching toward distant targets. Flying high or low, B-52s will provide an almost undetectable launch pad for missiles. They can also carry regular load of gravity bombs, and strike up to five targets on single mission.

Capability has many faces at Boeing

RESEARCH STATION. Model of space research station designed by Boeing to accommodate12 men and remain in earth orbit, serving as research station or interplanetary launch site.

SPACE CHAMBER. Boeing multi-stress chamber simulates six conditions of space travel in research to develop protective environments required for space vehicle crews. Chamber will also be used to test conditions in moon stations.





"FLYING" BOAT. Drawing of 115-foot hydrofoil craft Boeing is building for U.S. Navy. Riding out of water, hydrofoil will "fly" on underwater wings at speeds up to 45 knots. Powered by two 3000-hp gas turbine engines, craft will be the biggest hydrofoil ever built.

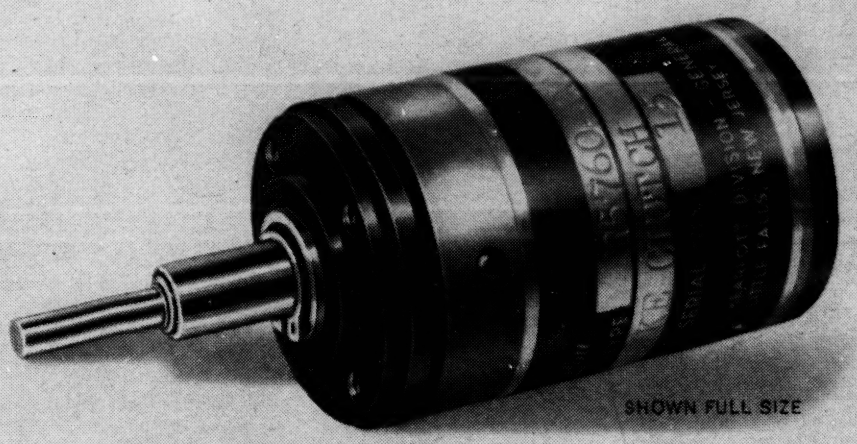
BOEING

when decision must race against time

Decision and control in today's military and governmental structure frequently must follow almost as soon as events occur. Yet the forces involved may span continents. And the information for control of these forces may be enormous in volume. ▪ To help leaders make decisions and exert control in response to events of the moment, we at System Development Corporation have helped create a new technology based on automated information processing assistance. ▪ SAGE is in operation as the first system of this new technology. Another — the SAC Control System — is in development. And we are working on two other extremely large systems in their initial stages. In contributing to these systems we have dealt mainly with their analysis and synthesis, training men in their use, instructing great computers on which they are based — and research into future generations of systems. ▪ We have developed an interdisciplinary approach to system development. The four fields are Operations Research, Engineering, Human Factors, Computer Programming. To staff our rapidly expanding programs in Santa Monica, California, Washington, D. C., and Paramus, N. J., we are seeking scientists and engineers in these fields. Please address Mr. R. L. Obrey, 2432 Colorado Avenue, in Santa Monica.

SYSTEM DEVELOPMENT CORPORATION

115.	Monsanto Chemical Co.	Saint Louis, Mo.	1,783
116.	Budd Co.	Philadelphia, Pa.	1,739
117.	Esso Research & Engineering Co.	Linden, N. J	1,720
118.	Stauffer Aerojet Co.	Sacramento, Cal.	1,693
119.	Le Tourneau-Westinghouse Co.	Peoria, Ill.	1,675
120.	Dynatronics, Inc.	Orlando, Fla.	1,648
121.	United Electro-dynamics, Inc.	Pasadena, Cal.	1,607
122.	Tracerlab, Inc.	Waltham, Mass.	1,588
123.	T R G, Inc.	Syosset, N. Y.	1,577
124.	Republic Aviation Corp.	Farmingdale, N. Y.	1,513
125.	Universal Match Corp.	Saint Louis, Mo.	1,478
126.	Barnes Engineering Co.	Stamford, Conn.	1,452
127.	Watkins-Johnson Co.	Palo Alto, Cal.	1,434
128.	AFN Inc.	Los Angeles, Cal.	1,425
129.	Federal Electric Corp.	Paramus, N. J.	1,415
130.	Hiller Aircraft Corp.	Palo Alto. Cal.	1,406
131.	Developmental Engineering Corp.	Leesburg, Va.	1,403
132.	Perkin-Elmer Corp.	Norwalk, Conn.	1,401
133.	Continental Aviation & Engineering Corp.	Detroit, Mich.	1,380
134.	Chamberlain Corp.	Waterloo, Iowa	1,377
135.	Arinc Research Corp.	Washington, D. C.	1,360
136.	Underwood Corp.	Van Nuys, Cal.	1,349
137.	Huyck Corp.	Huntington Station, N.Y.	1,344
138.	Polarad Electronics Corp.	Long Island City, N. Y	1,300
139.	American Electronic Laboratories, Inc.	Philadelphia, Pa.	1,299
140.	American Cyanamid Co.	New York, N. Y.	1,296
141.	Clevite Corp.	Cleveland, Ohio	1,277
142.	Aero Systems Inc.	Santa Ana, Cal.	1,248
143.	Texaco Inc.	New York, N. Y.	1,226
144.	National Co., Inc.	Malden, Mass.	1,223
145.	Galloway (G. W.) Co.	Arcadia, Cal.	1,209
146.	Flexonics Corp.	Maywood, Ill.	1,202
147.	Maico Electronics, Inc.	Minneapolis, Minn.	1,194
148.	Pennsalt Chemicals Corp.	Philadelphia, Pa.	1,190
149.	Emerson Electronic Manufacturing Co.	Saint Louis, Mo.	1,178
150.	Goodrich (B. F.) Co.	Akron, Ohio	1,174
151.	Bulova Research & Development Laboratories, Inc.	Woodside, N. Y.	1,171
152.	Pickard & Burns, Inc.	Needham, Mass.	1,165
153.	Emerson Radio & Phonograph Corp.	Jersey City, N. J.	1,143
154.	Beckman Instruments, Inc.	Fullerton, Cal.	1,132
155.	Electronic Communications, Inc.	Saint Petersburg, Fla.	1,082
156.	Analytic Services, Inc.	Santa Monica, Cal.	1,052
157.	Pacific Car & Foundry Co.	Renton, Wash.	1,033
158.	Pratt & Whitney Co., Inc.	Hartford, Conn.	1,033
159.	Control Instrument Co., Inc.	Brooklyn, N. Y.	1,032
160.	Manufacturing Laboratories, Inc.	Cambridge, Mass.	1,029



MINIATURE, HIGH PERFORMANCE MAGNETIC BRAKES AND CLUTCHES

Typical applications involving these Size 11 magnetic clutches, brake clutches, and brakes include service as output controls in mechanical differential computers, as motor brakes, and as speed changers and uncouplers. Kearfott can also provide magnetic clutches, brake clutches and brakes in various other sizes to suit desired applications. Components also available in sizes 8 and 6 diameters.

CHARACTERISTICS

	Magnetic Clutches		Magnetic Brake Clutch	Magnetic Brake
Unit No.	**R5750-001**	**R5750-002**	**R5760-001**	**R5770-001**
Size	11	11	11	11
Power input (Watts)	3	3	3	3
Clutch Torque (In. Oz.)	6 (energized)		4 (energized)	—
Brake Torque (In. Oz.)	—	—	6 (de-energized)	16 (energized)
Inertia (gm cm²)	.82 (energized) .56 (de-energized)		.82 (energized) .56 (de-energized)	.34
Engaging Surfaces	Steel	Brake Material	Steel and Brake Material	Steel
Environmental Performance	Per MIL-E-5272A			
Life (Cycles)*	3,000,000			

*1 Cycle=1 revolution of shaft engaged and 1 revolution of shaft disengaged, at 500 RPM.

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

161.	Babcock Radio Engineering, Inc.	Costa Mesa, Cal.	1,029	184.	Hermes Electronics Co.	Cambridge, Mass.	838	207.	C. G. S. Laboratories, Inc.	Stamford, Conn.	684
162.	Geotechnical Corp., The	Garland, Tex.	1,014	185.	Gulton Industries, Inc.	Metuchen, N. J.	819	208.	Stelma, Inc.	Stamford, Conn.	670
163.	Stoddart Aircraft Radio Co.	Hollywood, Cal.	1,001					209.	American Potash & Chemical Corp.	Whittier, Cal.	664
164.	DuMont (Allen B.) Laboratories, Inc.	Clifton, N. J.	972	186.	Nuclear Metals, Inc.	Concord, Mass.	800	210.	National Drug Co.	Philadelphia, Pa.	657
165.	Scope, Inc.	Fairfax, Va.	960	187.	Wyandotte Chemicals Corp.	Wyandotte, Mich.	781	211.	Maurer (J. A.) Inc.	Long Island City, N. Y.	654
166.	Lockheed Aircraft Service, Inc.	Ontario, Cal.	957	188.	Experiment, Inc.	Richmond, Va.	770	212.	General Applied Science Laboratories	Hempstead, N. Y.	654
167.	Hamilton Watch Co.	Lancaster, Pa.	955	189.	Continental Motors Corp.	Muskegon, Mich.	761	213.	Technitrol Engineering Co.	Philadelphia, Pa.	649
168.	United States Steel Corp.	Pittsburgh, Pa.	953	190.	Power Generators, Inc.	Trenton, N. J.	757	214.	Santa Barbara ResearchCenter	Goleta, Cal.	648
169.	Dewey (G. C.) Corp.	New York, N. Y.	931	191.	Ball Brothers Research Corp.	Boulder, Colo.	751	215.	Aeronca Manufacturing Corp.	Middletown, Ohio	646
170.	Ewen Knight Corp.	Needham, Mass.	925	192.	Kidde (Walter) & Co., Inc.	Belleville, N. J.	749	216.	Westrex Corp.	New York, N. Y.	645
171.	National Cash Register Co.	Dayton, Ohio	920	193.	Consolidated Electrodynamics Corp.	Pasadena, Cal.	746	217.	Wyle Laboratories	El Segundo, Cal.	641
172.	Mingo Electronic Corp.	Miami, Fla.	909	194.	Crucible Steel Co. of America	Midland, Pa.	745	218.	Plasmadyne Corp.	Santa Ana, Cal.	638
173.	Jansky & Bailey	Washington, D. C.	908	195.	Packard-Bell Electronics Corp.	Los Angeles, Cal.	740	219.	Thompson (John I.) Co.	Washington, D. C.	630
174.	All American Engineering Co.	Wilmington, Del.	902	196.	Stearns-Rogers Manufacturing Co.	Bakersfield, Cal.	739	220.	Lenkurt Electric Co., Inc.	San Carlos, Cal.	621
175.	Newport News Shipbuilding & Dry Dock Co.	Newport News, Va.	893	197.	Kennedy (D. S.) & Co.	Cohasset, Mass.	737	221.	Carrier Corp.	Syracuse, N. Y.	621
176.	Bolt Beranek & Newman	Cambridge, Mass.	893	198.	Aero Geo Astro Corp.	Alexandria, Va.	730	222.	General Analysis Corp.	Santa Monica, Cal.	618
177.	General Electronics Laboratories	Boston, Mass.	884	199.	Consultant & Designers, Inc.	Huntsville, Ala.	720	223.	S. F. D. Laboratories, Inc.	Union, N. J.	618
178.	United States Rubber Co.	New York, N. Y.	878	200.	Instruments for Industry, Inc.	Mineola, N. Y.	717	224.	American Optical Co.	Southbridge, Mass.	610
179.	National Research Corp.	Cambridge, Mass.	866	201.	Lear, Inc.	Santa Monica, Cal.	714	225.	Planning Research Corp.	Los Angeles, Cal.	604
180.	International Harvester Co.	Melrose Park, Ill.	860	202.	Allied Chemical Corp.	Hopewell, Va.	710	226.	Mine Safety Appliances Co.	Pittsburgh, Pa.	601
181.	Cleveland Pneumatic Industries, Inc.	El Segundo, Cal.	856	203.	C-E-I-R, Inc.	Arlington, Va.	692	227.	Fischer & Porter Co.	Warminster, Pa.	601
182.	Webcor, Inc.	Chicago, Ill.	840	204.	Dresser Industries, Inc.	Houston, Tex.	688	228.	Hycon Manufacturing Co.	Pasadena, Cal.	600
183.	Operations Research, Inc.	Silver Spring, Md.	838	205.	Ethyl Corp.	Detroit, Mich.	687	229.	Seismograph Service Corp.	Tulsa, Okla.	595
				206.	Comstock & Westcott, Inc.	Cambridge, Mass.	687	230.	Clark (David) Co., Inc.	Worcester, Mass.	595

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QUALIFIED, precisely-wound, individually calibrated units that meet or exceed the requirements of:

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MIL-B-7258 (USAF)
MIL-B-7370A
MIL-B-5491A (Aer)

SPECIALLY DESIGNED temperature detectors for use in modern jet and piston-powered aircraft, made to the Airframe Manufacturer's specifications for sensing the temperatures of:

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PLATINUM-WOUND TRANSDUCERS for use in MISSILES, to measure the temperatures of:

LIQUID OXYGEN
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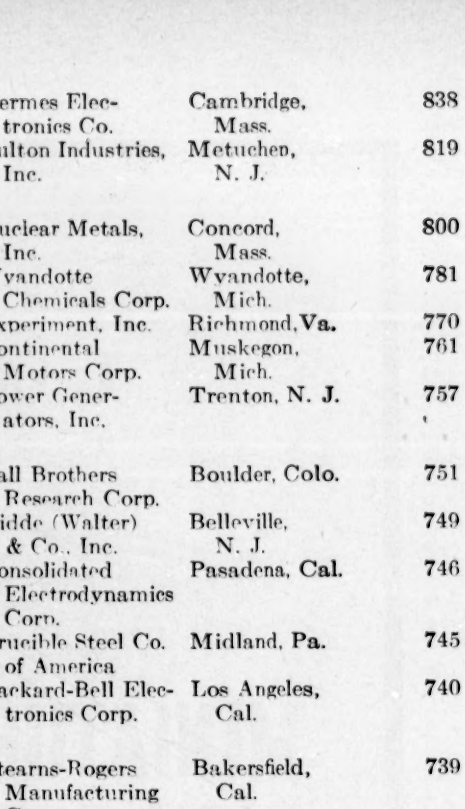
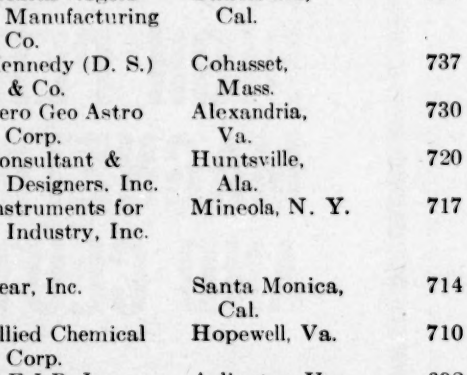
and other media to customer's specifications





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New

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FOR AIRBORNE OPTICAL SYSTEMS & THOSE REQUIRING LOW INERTIA

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A mirror can now be designed thinner to take tighter space requirements, with decreased weight and equal rigidity, without sacrificing accuracy. Send specs for immediate estimate.

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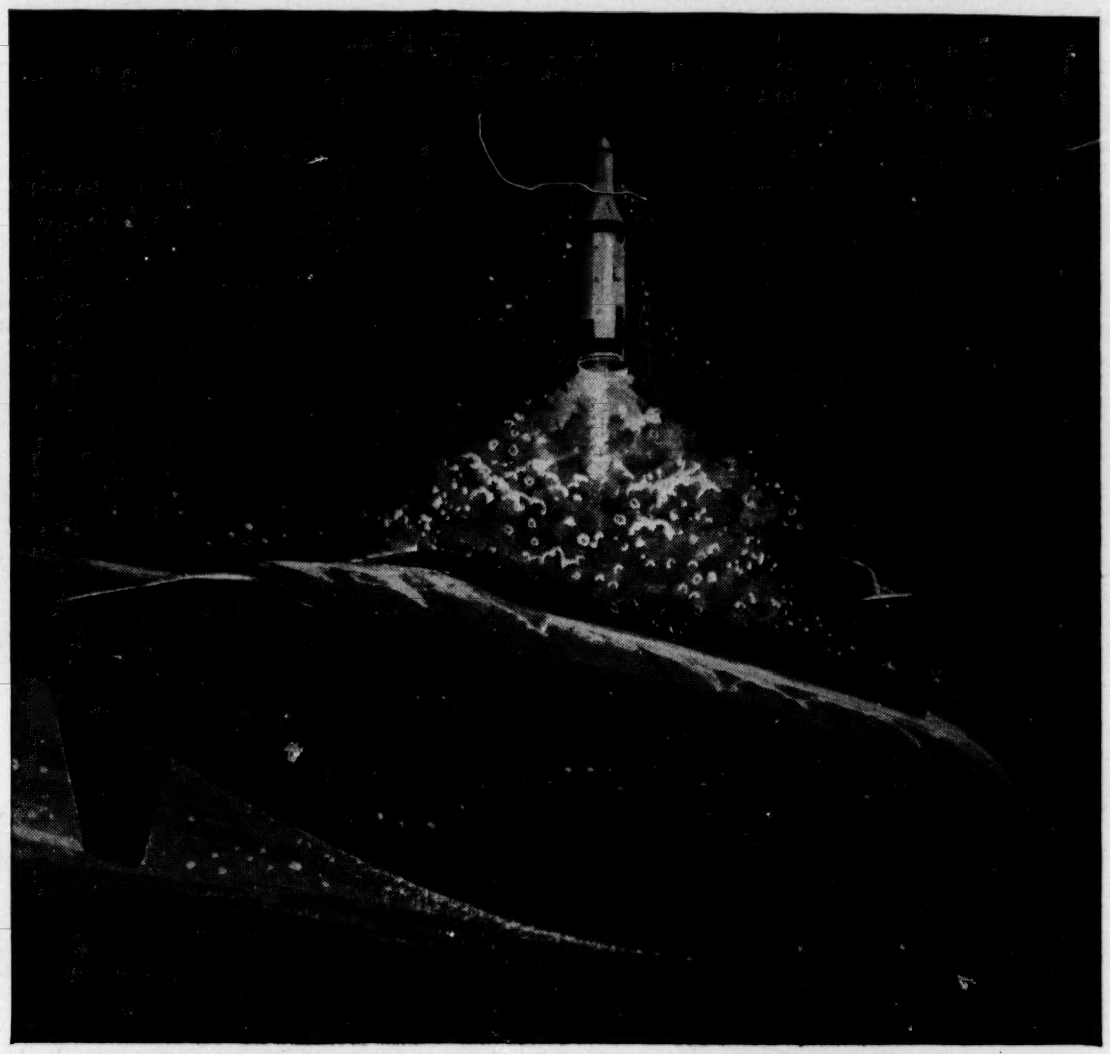

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for the Polaris missile.

Engineers: *Kearfott offers challenging opportunities in advanced component and system development*

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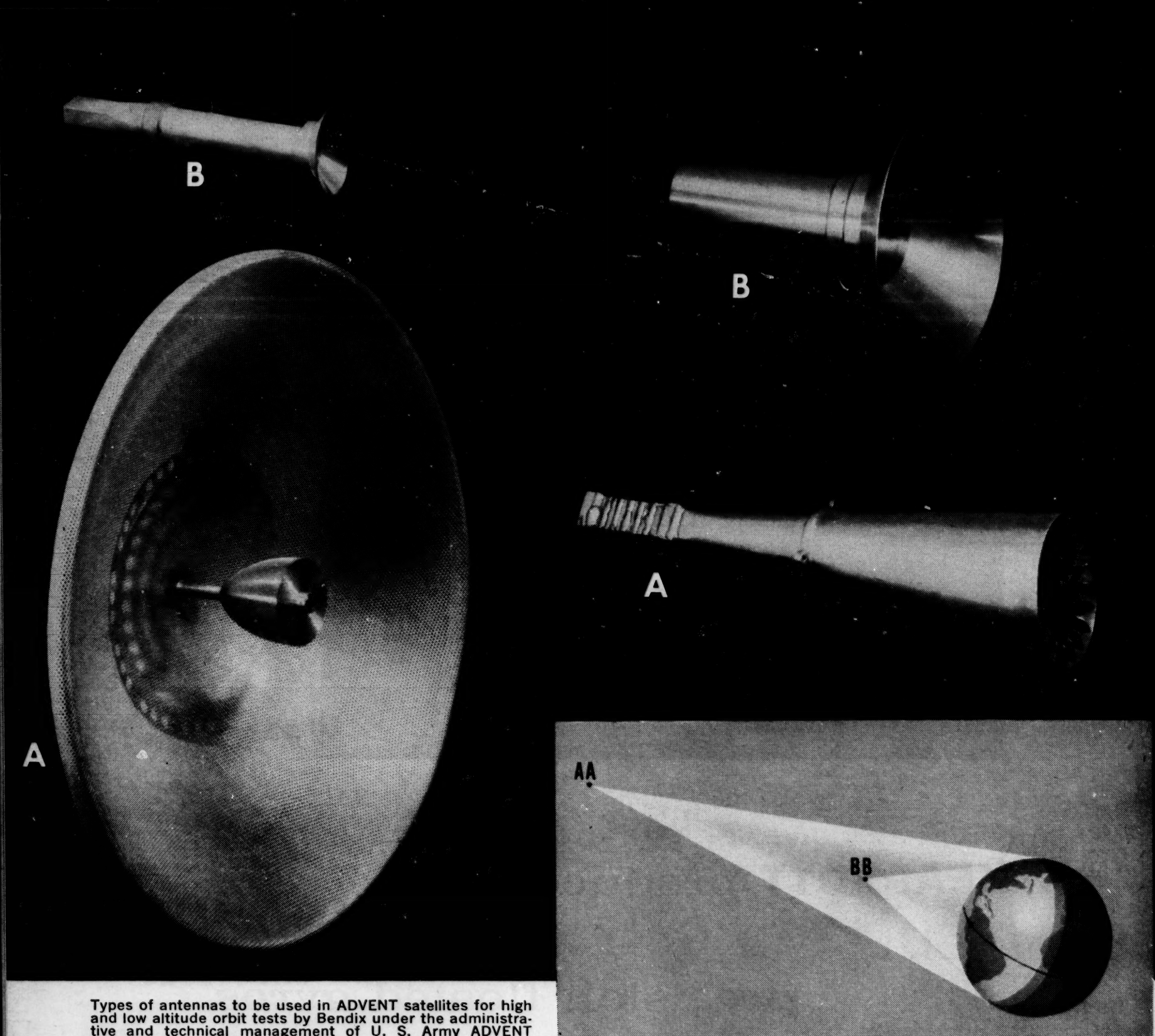


Types of antennas to be used in ADVENT satellites for high and low altitude orbit tests by Bendix under the administrative and technical management of U. S. Army ADVENT Management Agency and technical direction of U. S. Army Signal Research & Development Laboratory.

WHY FOUR ANTENNAS? Because the Advent communications satellite repeater will be tested in both high and low orbits, with each repeater receiving on one microwave frequency but re-transmitting on another. These specially polarized antennas, developed by Bendix, will withstand the extremes of launch acceleration, vibration, and temperature, as well as one year of continuous operation in orbit. Better scientists and engineers are invited to join the Bendix team.

BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

THE Bendix CORPORATION

Financial Briefs

Varo, Inc., had net earnings of $125,-175 on sales of $3,342,871 for the first nine months of the current fiscal year beginning May 1, 1960. During the same period a year ago, net earnings were $54,788 on sales of $2,560,191.

National Airlines, Inc., operating revenues for the six months ended Dec. 31, 1960, were $30,780,009. Operating expenses were $35,820,319. Net loss after other income, deductions and tax provisions were added was $4,038,205.

Litton Industries had six-month sales of $108,202,000, an increase of 40% over last year's figure of $77,401,000. Net earnings for the period were $4,-448,000 compared with $3,248,000 a year ago.

Radio Corp. of America sales for 1960 were $1,494,896,000, a 7% rise over 1959. Net earnings were $35,117,-000, off 13% from the 1959 figure of $40,142,000.

Standard Kollsman Industries, Inc., and its domestic and foreign subsidiaries had consolidated net sales of $95,568,805 and a net income of $3,-459,992 in 1960. Figures for 1959 were $73,765,428 and $1,523,379.

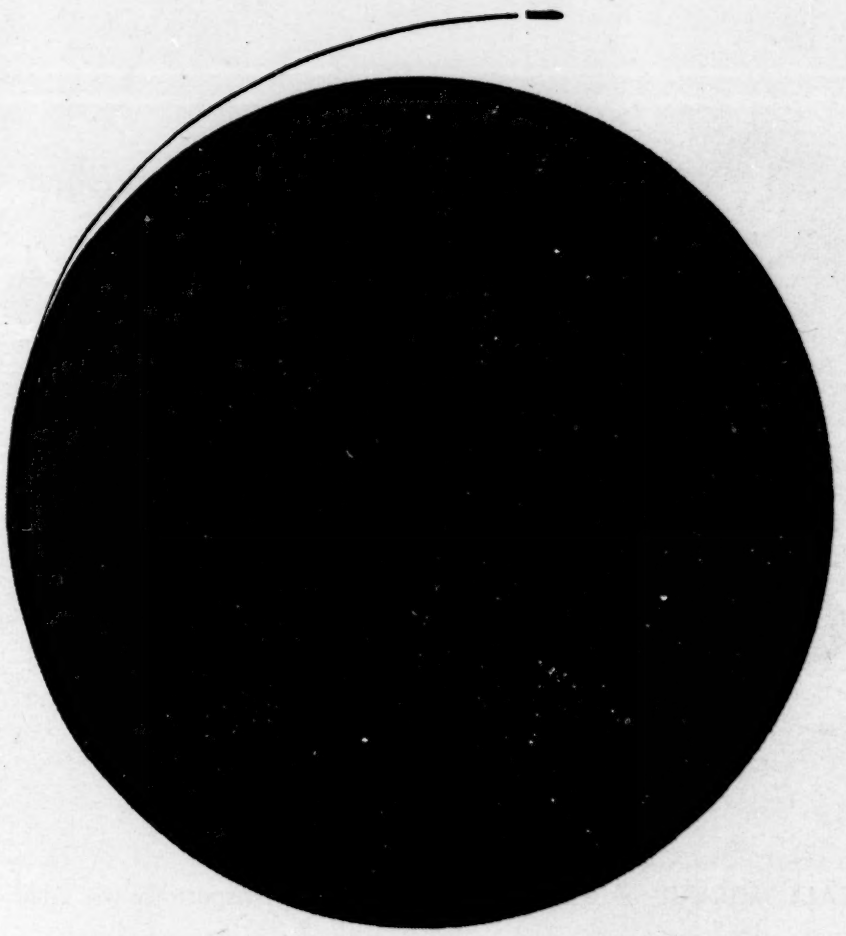
The Garrett Corp. reports sales for the first six months ending Dec. 31 of $94,506,000 and a net profit of $711,000 or 67 cents per share on the 1,064,971 shares outstanding at the beginning of the period.

Corning Glass Works' sales in 1960 were $214,871,286, an increase of 6.7% over the $201,370,386 total for 1959. Earnings last year were $22,054,741 or $3.23 per share of common stock. In 1959 net income was $24,335,899 or $3.57 per share.

Varian Associates had sales of $12,-747,932 and earnings of $865,008 in the first quarter of 1960. 1960 sales increased 18% over the 1959 figure of $10,795,591 and 1960 earnings were up 11% from the $776,710 recorded in 1959.

Control Data Corp.'s sales in the first six months of Fiscal 1960, ending Dec. 31, were $8,543,126, and net income after taxes and a deduction of $100,000 for product warranties was $403,722. This compares with net sales of $3,889,273 and net earnings of $249,518 in the same period of the previous year when no warranty reserve provision was made.

GALLERY PROPELLANT BRIEFS



What comes after Liquid, Solid and Hybrid Propulsion?

Inquiries of the most basic sort are now going on in Callery's continuing exploration of energy frontiers. Under a new government contract, we have been selected to develop and expand an unusual concept of energy conversion, the nature of which is highly classified. We can only say it's our most exciting and far-ranging program to date.

Callery's new program is another example of our diversified efforts in energy enhancement and containment. The same skills which brought the boranes from test-tube to tonnage production are being extended into Nitronium Perchlorate solid oxidizer; monopropellants and hybrid systems; subcontract capabilities and Systems Management for research, process development and production of energy requirements for defense and space exploration. Perhaps these skills can expand your horizons, too.

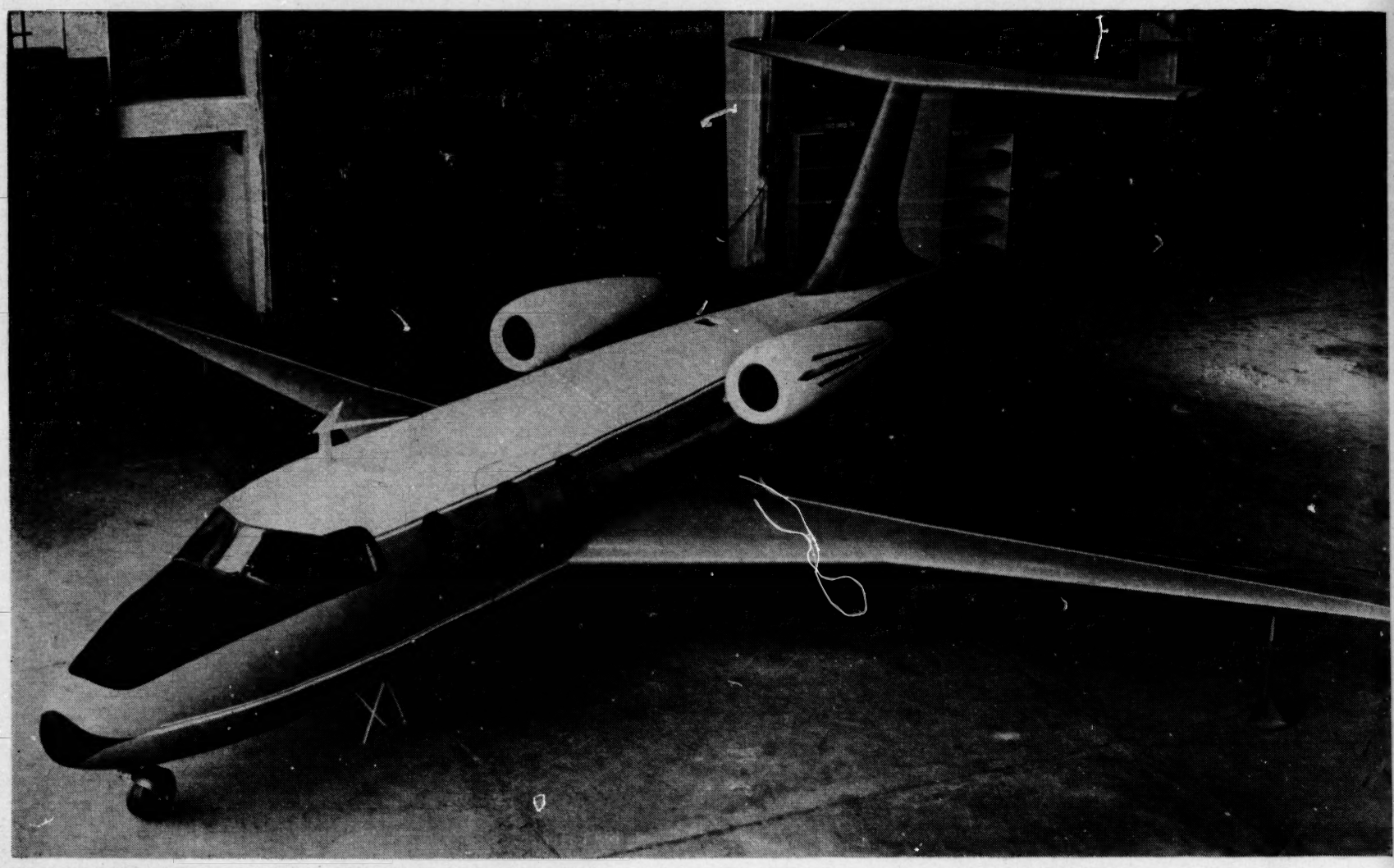
Room for inquiring minds

Callery's wide-ranging programs haye created new opportunities for scientists at the Ph. D. level with an interest in:

- **SYNTHETIC INORGANIC CHEMISTRY**
- **APPLIED PHYSICS**
- **PHYSICAL CHEMISTRY**

These challenging jobs are at the main laboratories in Callery, Pa. and at the new missile laboratory in Van Nuys, Calif. We invite you to write or call Callery to discuss your background as it may relate to these opportunities.

Callery Chemical Company, Defense Products Department
Headquarters: Callery, Pennsylvania; Telephone Evans City (Pa.) 3510
West Coast: 15537 Lanark Street, Van Nuys, California; Telephone STate 1-5761



FULL-SCALE MOCKUP of Israeli B-101C executive transport shows T-tail layout of empennage. A V-tail was part of earlier design.

Israeli Aircraft Surveying B-101C Market

By Erwin J. Bulban

Israeli Aircraft Industries is conducting a combined survey of market potential and sales and service facilities for a new six- to nine-place light twin-jet executive transport, which it says will sell for $350,000 fully equipped.

Major portion of the engineering of its B-101C twin-jet (AW Mar. 6, p. 87) has been completed under the direction of Dr. Erich Schatzki, IAI's chief engineer, whose background includes positions with Heinkel, Fokker and Republic Aviation Corp. A full-scale mockup of the B-101C has been completed at IAI's Lod Airport facility on completion of basic configuration, design studies of which started some 10 months ago.

IAI executives told AVIATION WEEK that their plans are to build two flying prototypes and a static test model as soon as current surveys covering market, potential sales and service organizations in the United States are completed. They estimate that they can have the first flying prototype airborne in 18 months from go-ahead.

Plan initially is to build the airframe in Israel, ferry or ship them to the United States, where a distributor would prepare them for delivery to customers. Should enough interest develop indicating desirability for production here, the company says it will discuss production licensing arrangements with a manufacturer.

Biggest market potential for the airframe is considered to be the executive field, although the company feels that some interest may also develop among charter operators.

Major Handicap

IAI feels that the biggest handicap in cracking this market thus far has been price: therefore design program has been geared to developing an airplane featuring low initial and operating costs.

To minimize costs, the completed airplane will represent a design meeting Federal Aviation Agency Part 03 specifications where these requirements are adequate without degrading FAA Part 04B transport category requirements. The airplane's takeoff and landing requirements are directed at fulfilling FAA S.R. 422B jet category regulations. The plan is to build the airplane within current state-of-the-art design, avoiding exotic and costly new features.

Fuselage is of cylindrical layout providing minimum wetted area and maximum structural strength, with a major portion of the fuselage of constant section to ease production and tooling requirements. Conventional jet-type fail-safe construction, utilizing multiple load-paths to increase fatigue life, is also utilized.

Placement of engines aft of the fuselage, in the style set by the Sud Caravelle, permits a clean wing and short landing gear, making it possible to enter and depart from the fuselage without the need for special loading equipment. Lowness relative to the ground is also credited with improving landing and takeoff characteristics through maximum use of ground effect.

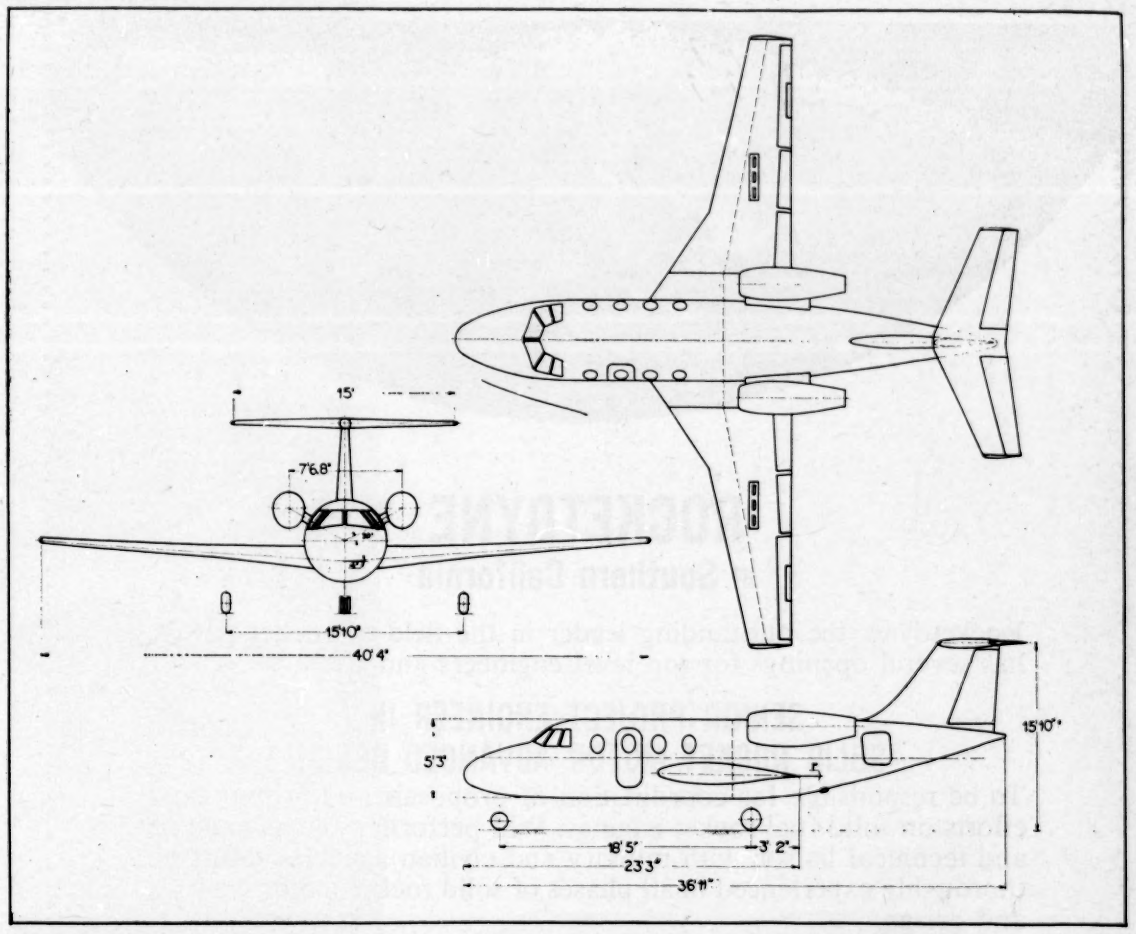
Baggage compartment exterior access door provides maintenance personnel with easy egress to fuel, hydraulic and electrical system accessories in addition to pressurization and air conditioning equipment in the accessory bay, which is separated from the baggage compartment by a bulkhead. Autopilot system and batteries are also located in rear compartment. A panel in the fuselage belly provides access to the fuel booster pumps, while two large panels in the nose permit access to radar gear, navigation, VHF, ILS and automatic direction finder equipment.

Cockpit equipment includes: Collins 17L7 transmitter and 51X2 receiver for main communications and a

Collins 17L8 for standby; Collins 51X2 VHF receiver, Lear situation display indicator and Collins 51X3 receiver and Collins 331H-1 course selector indicator as the navigation VOR system. Two ILS systems are programed, one functioning with the VOR No. 1 navigation localizer and the other with the No. 2 VOR localizer. Lear ADF-200 automatic direction finder, in duplicate, is planned as is an all-weather RCA AVQ-50 lightweight radar and a Flite-Tronics CA-2A transistorized intercom.

B-101C's electrical system consists of 28-v.d.c. and three-phase 115-v. 400 cps. a.c. power supply; the main d.c. supply system receiving power from two starter generators feeding a nickel-cadmium battery.

Cabin will be pressurized at 8.32 psi. to maintain 6,000-ft. altitude when flying at 35,000 ft. and an oxygen system is designed so that when the cabin pressure altitude exceeds 9,500 ft., oxygen masks are automatically dropped in front of passengers.



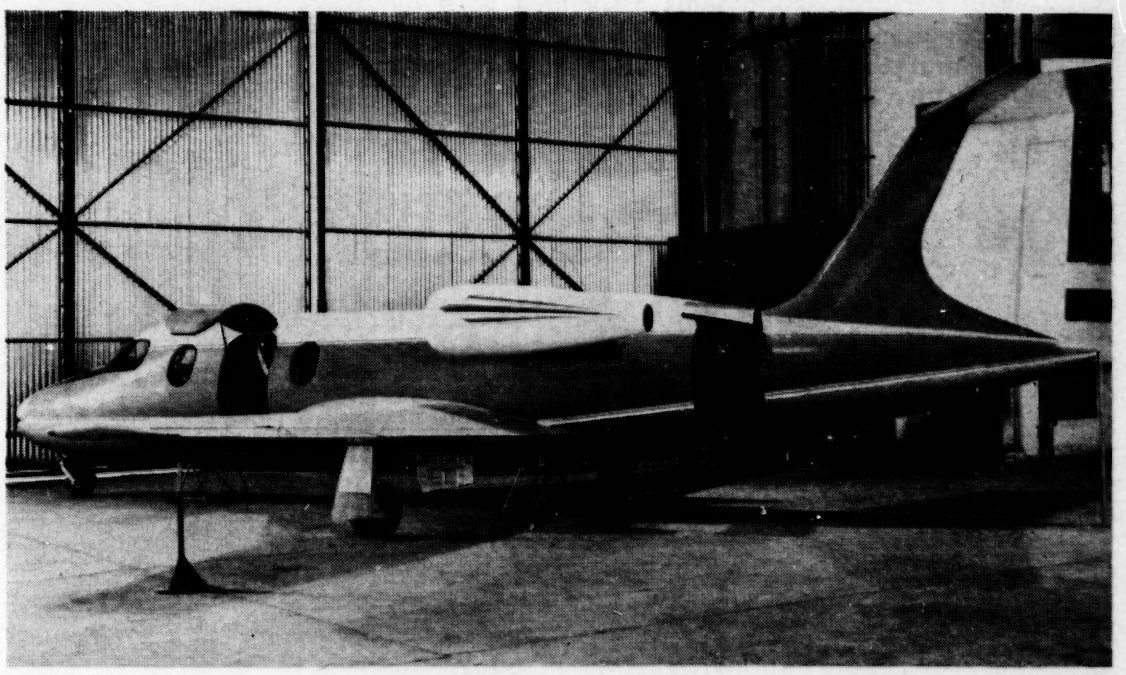
THREE-VIEW shows aft placement of engines, which permits short landing gear.

Powerplant Unit

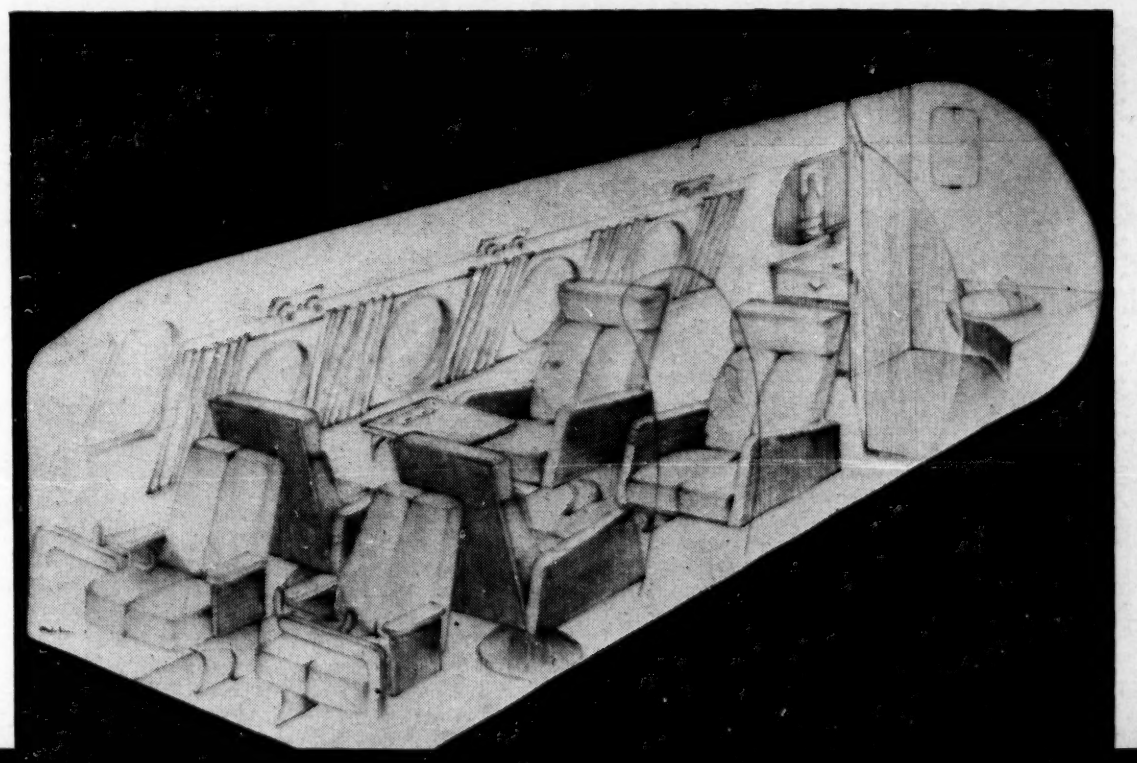
Powerplant system will consist of two General Electric CJ610-2Bs of 2,400 lb. static thrust rating at sea level, which IAI expects will be approved by Federal Aviation Agency by the end of this year. These are civil, derated versions of the military-developed J85. The Israeli firm plans to provide an engine exchange program for overhauled powerplants to obviate customer capital tie-up on engine spares. Engines will have available an eight-tank fuel system providing a total of 705 gal. Five integral wing tanks will carry a total of 334 gal. and three fuselage tanks will carry 371 gal.

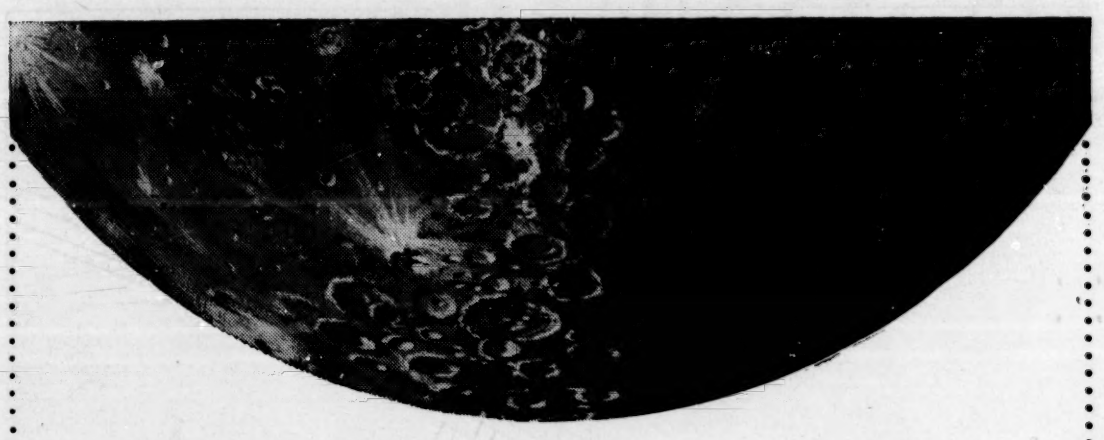
Israeli Aircraft Industries engineers estimate that the B-101C will operate with a full payload for a gross weight of 12,500 lb. at takeoff from 2,800-ft. runways, utilizing anti-skid brakes and engine thrust reversers providing 40% reverse power. Landing distance over a 50-ft. obstacle with this equipment is estimated at 2,900 ft. at 12,500-lb. gross weight and 2,250 ft. (which is landing weight) at 8,800 lb. Without thrust reversers, the landing distance over an obstacle is considered as 3,320 ft. at maximum gross weight and 2,620 ft. at 8,800 lb.

IAI estimates that the B-101C's flight operations cost per hour will total $59.93, utilizing one pilot (at $16,000 annual salary); total maintenance costs will run some $32.22 per hour and total depreciation costs at some $47.40 (with airframe being depreciated at $26.90, engines at $11.25, spare parts and ground equipment at $1.75 and electronics at $7.50). Total direct hourly operating costs are $142.55, based on utilization of 600



LOW ground clearance was designed to obviate need for door-stair or ramp. Six-passenger cabin configuration (below) has two swivel seats, separate lavatory compartment and food service area in rear. Baggage compartment behind engines is 4 ft. above ground level.





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To be responsible for coordination of proposals and promotional efforts on solid fuel rocket engines. Will perform systems analysis and technical liaison with military and civilian agencies. Must be thoroughly experienced in all phases of solid rocket motor analysis and design.

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To participate in fundamental studies basic to advanced nuclear propulsion devices. A specialized knowledge of materials, shielding requirements, and neutronics is helpful.

Send professional resume to Mr. A. D. Stoetzel, Professional Employment Office, 6633 Canoga Avenue, Canoga Park, Calif.

ROCKETDYNE
DIVISION OF NORTH AMERICAN AVIATION

hr. per year. Depreciation is considered over a 10-year period.

Breakdown of the $350,000 estimated total price includes $90,000 for engines and $45,000 for electronics equipment.

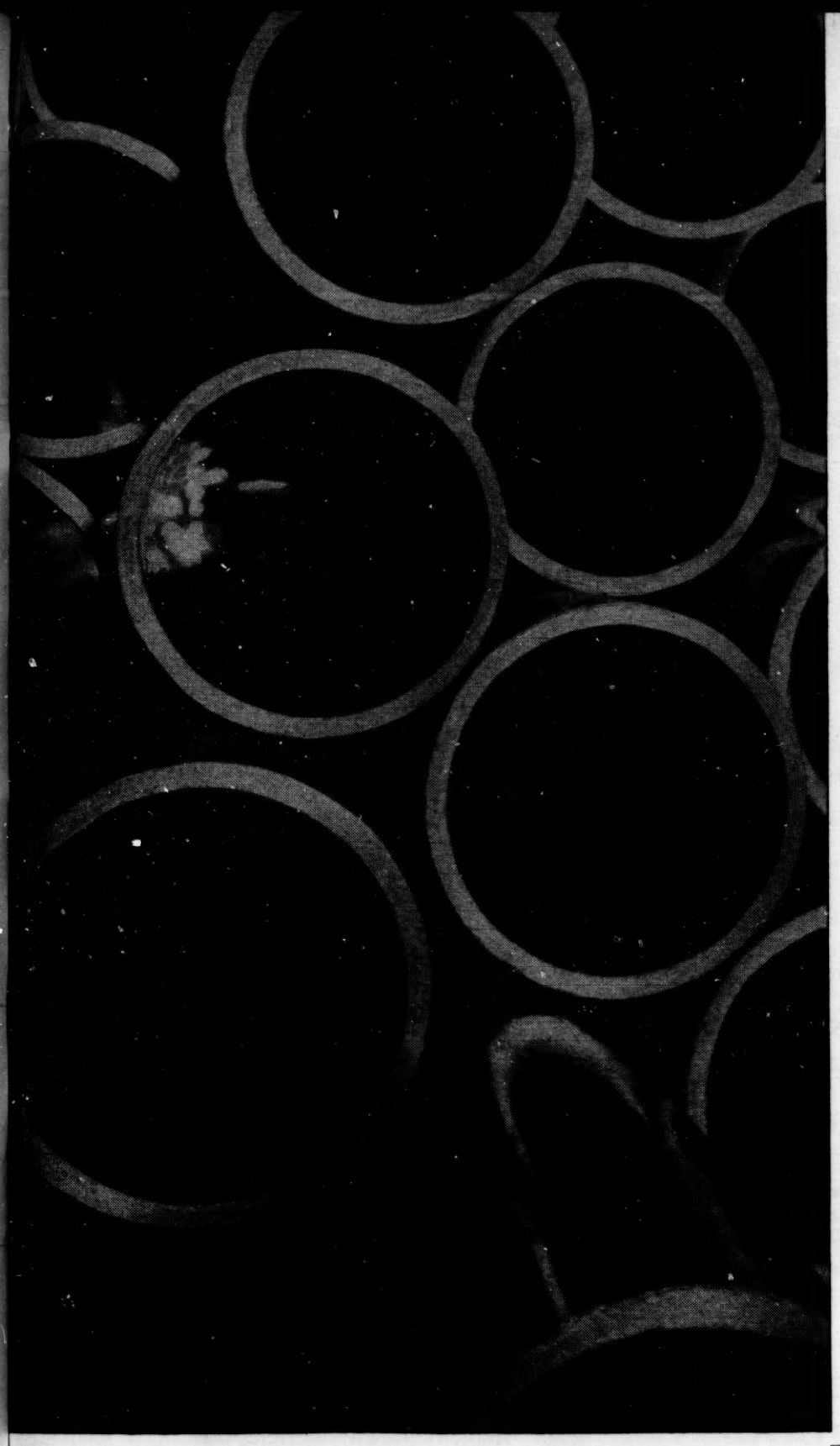
Ground equipment and spares (not including engines) are estimated at $14,000.

IAI B-101C Empty Weight

Fuselage structure	1,111 lb.
Wing (including stubs)	1,772 lb.
Tail assembly	320 lb.
Main landing gear	343 lb.
Nose landing gear	101 lb.
Powerplants with pods	1,000 lb.
Thrust reversers	140 lb.
Controls	196 lb.
Communications, navigation equipment	318 lb.
Electrical equipment	360 lb.
Instruments	37.5 lb.
Emergency equipment	13 lb.
Hydraulic system	64 lb.
Fuel system	148 lb.
Pressurization system	153 lb.
Oxygen system	64 lb.
Fire extinguishing system	45 lb.
Ventilation equipment	15 lb.
Support equipment and accessories	46.5 lb.
Furnishings	231 lb.
Residual fuel and oil	20 lb.
Hydraulic fluid	15 lb.

Israeli B-101C Executive

Length	36 ft. 11.4 in.
Height	15 ft. 10.1 in.
Span	40 ft. 4 in.
Mean aerodynamic chord	6 ft. 11.2 in.
Cabin length	13 ft. 6 in.
Cabin inside diameter	4 ft. 11 in.
Cabin outside diameter	5 ft. 3 in.
Wing loading (gross weight)	52.08 psf.
Wing loading (landing weight)	36.67 psf.
Center of gravity limits	24-38%
Weight empty	6,513 lb.
Landing weight	8,800 lb.
Gross weight	12,500 lb.
Rate of climb (at sea level)	6,100 fpm.
Rate of climb (at 20,000 ft.)	2,500 fpm.
Rate of climb (one engine out, sea level)	1,075 fpm.
Rate of climb (one engine out, 20,000 ft.)	375 fpm.
Range (takeoff weight, 4,720 lb. fuel, with 555 lb. reserve)	1,660 stat. mi.
Range (takeoff weight, 4,720 lb. fuel, 555 lb. reserve, at 35,000 ft., 60 mph. headwind)	1,520 stat. mi.
Top speed (at 35,000 ft.)	510 mph.
Most economical cruise speed	400 mph.



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For a very fundamental reason, more and more Engineers, Designers and Purchasing Agents are specifying USS National Electric Resistance Welded Steel Mechanical Tubing—it saves money.

Dimensional accuracy and closely controlled mechanical properties insure consistency—consistently low machining losses, uniform strength, low fabrication costs and high torsion resistance—and the tubing is smooth inside and outside.

Whether your tubing application requires the dependability for a load-carrying member or the surface smoothness quality for a hydraulic cylinder, USS National Electric Welded Mechanical Tubing must be your first consideration.

USS National Electric Welded Mechanical Steel Tubing is available in a wide range of cold drawn or hot rolled sizes from as small as ⅜″ x .028″ to as large as 5½″ x .250″. Your National Tube Distributors throughout the country will gladly show you how tubing can reduce your costs. See your USS National Tube Distributor.

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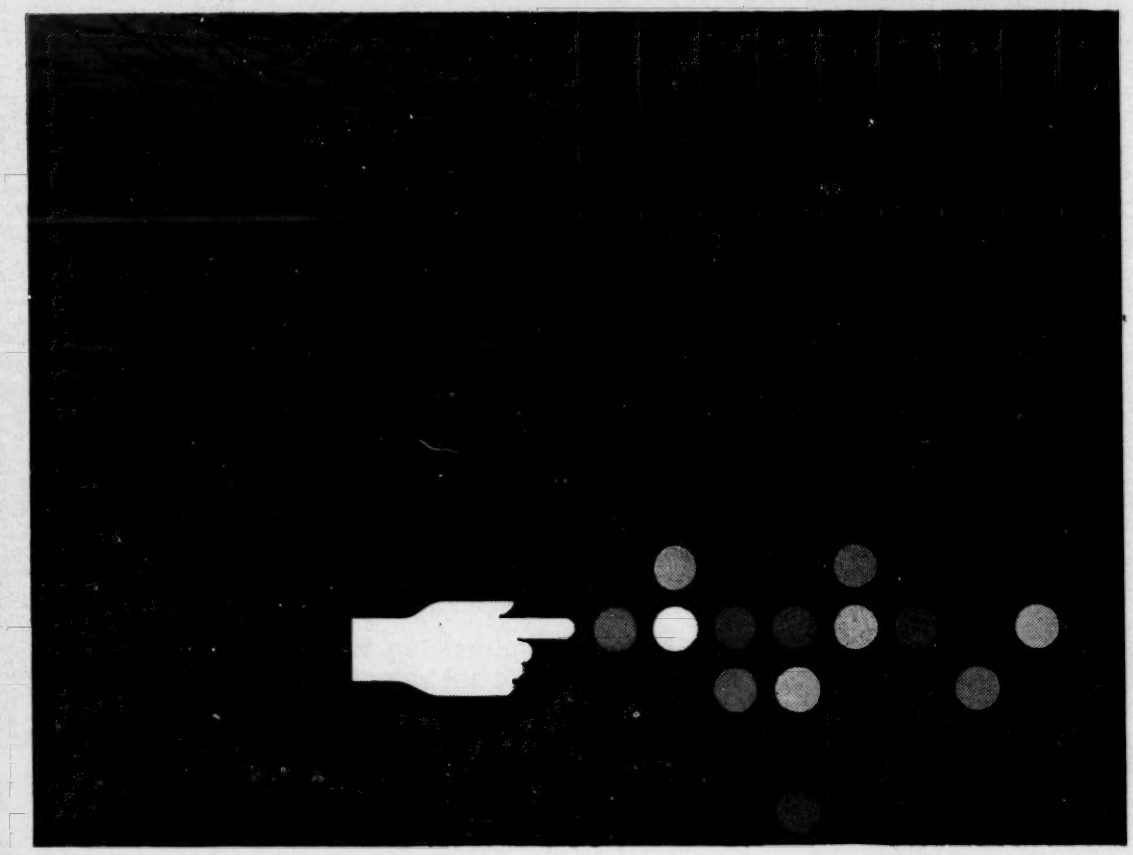


THINK, ACT! How will crews of aerospace vehicles perform under long periods of stress and confinement? Lockheed/Georgia finds accurate answers in the crew mockup section of its Behavioral Research Lab – just one of the many capabilities of its highly qualified Human Factors Research Group. **LOCKHEED/GEORGIA**

Marietta, Georgia

PROBLEMATICAL RECREATIONS 61

A prisoner is given 10 white balls, 10 black balls and two boxes. He is told that an executioner will draw one ball from one of the two boxes. If it is white, the prisoner will go free; if it is black, he will die. How should the prisoner arrange the balls in the boxes to give himself the best chance for survival?

—*Georgia Tech Engineer*

News from our Maryland Division: a new line of broadband antennas. Model 12E1-10 covers the frequency range of 100 to 1000 mc with a gain of 8 ± 1 db. Maximum VSWR: 2.0-1. Model 13E1-5 covers the range from 1000 to 5000 mc with a gain of 7 ± 1 db. Maximum VSWR: 2.2-1. Various polarizations can be provided in bandwidths of 10 to 1 or greater. Receptive people are directed to contact: Litton Systems, Inc., Maryland Division, 4900 Calvert Road, College Park, Maryland.

ANSWER TO LAST WEEK'S PROBLEM: Let M = my age in years, S = son's age, and F = father's age. My father is five times as old as my son, therefore: $F = 5S$. When I am as old as my father, my son will be $F - M$ years older than he is now; his age then will be $S + F - M$. Since this is 8 years more than my present age, $S + F - M = M + 8$. The third equation is: $F + M = 100$. Solving these equations gives $S = 13$, and hence $M = 35$, and $F = 65$.

LITTON INDUSTRIES
Beverly Hills, California

PRIVATE LINES

Beech Baron twins retrofitted with Turbomeca Astazou 470-shp. turboprop engines will be designated the Marquis. Retrofitting is being done by Sferma, subsidiary of Sud Aviation.

Federal Aviation Agency will hold a series of regional conferences for pilots and plane owners, called "Air-Share" meetings, starting Apr. 11 at Santa Monica, Calif., in the Monica Hotel. Other meetings to explore problems of general aviation will be held at Hotel St. Nicholas, Springfield, Ill., Apr. 19; Hotel Shelburn, Atlantic City, N. J., Apr. 27, and Hotel Heidelberg, Jackson, Miss., May 2. Meetings will be held by FAA Bureau of Flight Standards and will explore possible rule-making in areas of "cribbing" in airman examinations; greater control by instructors; new classes of roto-craft pilot ratings and special ratings for new light turbine-powered planes.

Aero-Rama air show, sponsored by Borrego Springs (Calif.) Chamber of Commerce and Borrego Valley Airport Authority, will be held Apr. 8-9 at Borrego Springs. Program includes stunt flying and a parachute jumping contest.

Agricultural Aviation Engineering Co., Santa Clara, Calif., has acquired Span Flow system of aircraft dusting equipment from Missen Aviation Products.

Guide for flight test for private pilot certification has been issued by Federal Aviation Agency as preparation for maneuvers, emergencies and flight planning knowledge needed by the private pilot applicant. Guide may be obtained from Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 10 cents.

Beech Aircraft Corp. will make free major inspections of its seven models to help owners increase operating efficiency, starting Apr. 6 at Cutter Aviation, Phoenix, Ariz. Paul E. Allen, Beech manager of parts and service, said inspections, part of 13th annual Beechcraft Service Clinic, will be held in 40 U. S. locations through September.

Paul F. Bikle, Lancaster, Calif., has claimed a new world gliding altitude record, flying his Schweizer I-23E sailplane to 46,267 ft. over Mojave, Calif., on Feb. 25. Previous record of 42,100 ft. was set in 1959 by William S. Ivans, Jr., San Diego, Calif. Record is subject to confirmation by Federation Aeronautique Internationale.

Executive Mustang Cruises at 370 mph.

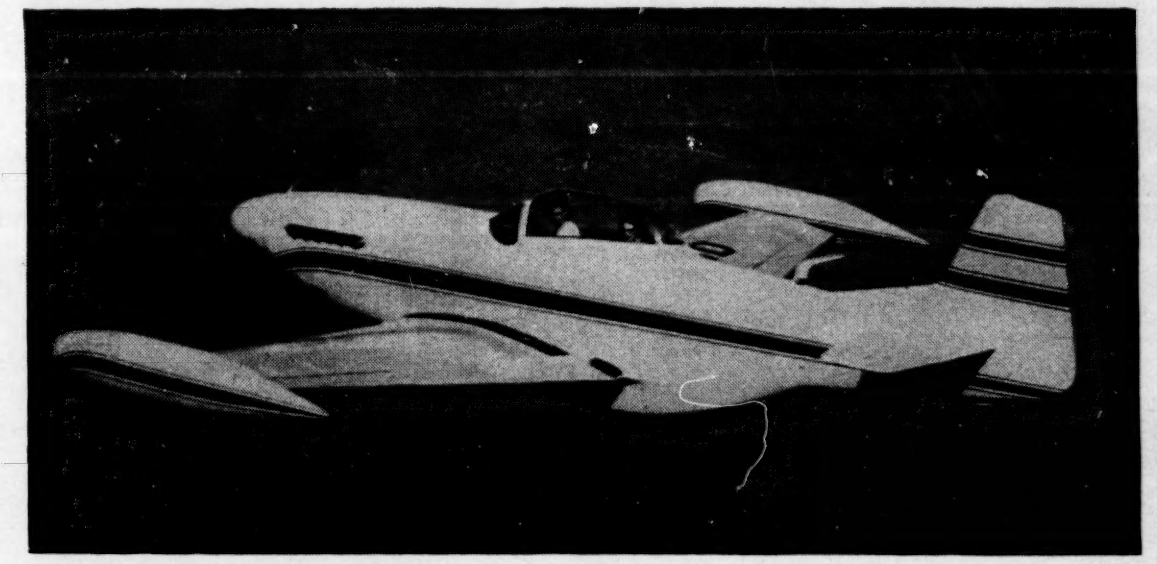
Sarasota, Fla. – Trans-Florida Aviation, Inc., has put its North American F-51 executive Mustang into production, after five years of research that produced six prototypes of varying configurations.

Production model is designated the Cavalier 2000 and sells for $32,500 flyaway at Sarasota. The airplane is licensed in an aerobatic category and is stressed for 9g with full tip tanks, holding 96 gal. each, and maximum gross weights. Total fuel capacity is 376 gal.

W. P. Brownell, vice president, said the company has 18 available airframes and now has one on the line, plus a demonstrator. Trans-Florida also owns a TF-51, the dual-control Mustang developed by U. S. Air Force for pilot checkouts.

The Cavalier is powered by a Rolls-Royce/Packard Merlin in-line piston engine, which includes the F-51's two-stage, two-speed supercharger system. Factory zero-time engines are available at Sarasota for about $3,000. Propeller is a paddle-bladed Hamilton Standard 24D50 constant speed, approved for 1,200 hr. between overhauls.

Major exterior change is in the Plexiglas high visibility canopy, which is tinted to filter the sun's rays. Windshield is bird-proof.



CAVALIER 2000 executive Mustang has maximum range of 2,000 stat. mi. Speed range is from 490 mph. (red line) to 86 mph. stall speed. Takeoff over 50-ft. obstacle is 1,850 ft.

Trans-Florida has designed two baggage compartments in each wing to provide space for 400 lb. Gross weight is 10,500 lb. and normal cruise speed at 25,000 ft. is 370 mph.

In converting the Cavalier, Trans-Florida installs metal-sheathed Aeroquip hose and fittings through the hydraulic and fuel systems. Electrical wiring is replaced to airline standards, or better.

Pilot's instrument panel has been redesigned to include navigation and radio controls directly in front. Standard instrumentation includes a Sperry H-6 electric, non-tumbling gyro horizon and the Sperry C-4 Gyrosyn compass. Provision has been made for dual omni with automatic glide slope, automatic direction finder and 360-channel crystal-controlled transceivers.

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Mr. Garrett Sanderson,
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U. S. Business & Utility Aircraft Shipments

January 1961

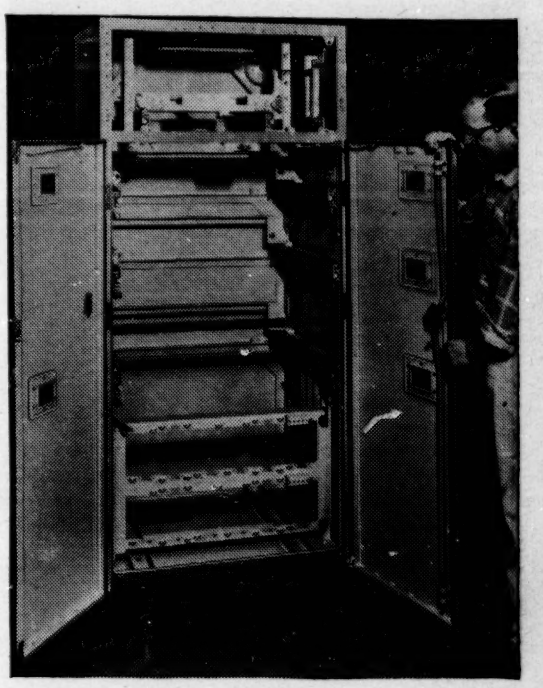
Make & Model	No. of Units	Net Billings
Beech 18 Super	5	
33 Debonair	21	
35 Bonanza	34	
50 Twin-Bonanza	7	$767,000
55 Baron	13	
65 Queen Air	3	
95 Travel Air	1	
Callair A-6	1	$7,000
Cessna 150	35	
172, Skyhawk	83	
175, Skylark	15	
180	31	$4,611,000
182, Skylane	84	
210	45	
310	20	
Champion 7EC Traveler	0	
7FC Tri-Traveler	4	
7GCA, B Challenger	9	$97,000
7HC DX'er	0	
7KC Olympia	2	
Commander 500A, E	4	
560E	0	
680E, F	4	$767,000
720	1	
Mooney Mark 21	12	$227,000
Piper PA-18-A Super Cub	17	
PA-22 Tri-Pacer	2	
Colt	65	
PA-23 Apache	7	
PA-23 Aztec	25	$3,156,000
PA-24 Comanche 180	32	
PA-24 Comanche 250	52	
PA-25 Pawnee	20	
Totals	654	$12,253,000

Note: January 1961 total units shipped and factory net billings are below the same month last year when 704 aircraft having a factory value of $12,979,000 were delivered and are also below December 1960's total of 741 units valued at $14,780,000, reflecting in the cases of some manufacturers, a lessening of units shipped to reduce over-inventory problems in the field caused by customer resistance due to business instability concurrent with the U.S. recession, and due to exceptionally bad weather in some sections of the country which reduced dealer demonstration capabilities. Twin-engine deliveries in January 1961 (90), held up well, comparing with 91 shipped in the same month last year, helping to maintain a high level of dollar volume. Reduction in Beech Travel Air deliveries is indicative of phase-out period usually preceding introduction of an improved model.

Kamov Builds Mail Aerosleigh

Russia's new Sever-2 "Aerosleighs," built at the factory headed by Soviet helicopter designer N. I. Kamov, have gone into mail delivery service in far-northern areas of the USSR. Cab of the Sever-2 is a conventional Pobeda automobile. Powered by a 260-hp. aircraft engine driving a three-bladed propeller, the ski-mounted vehicle is said to have an "average speed" of about 31 mph. and is capable of carrying over 660 lb. of cargo.

Example . . .



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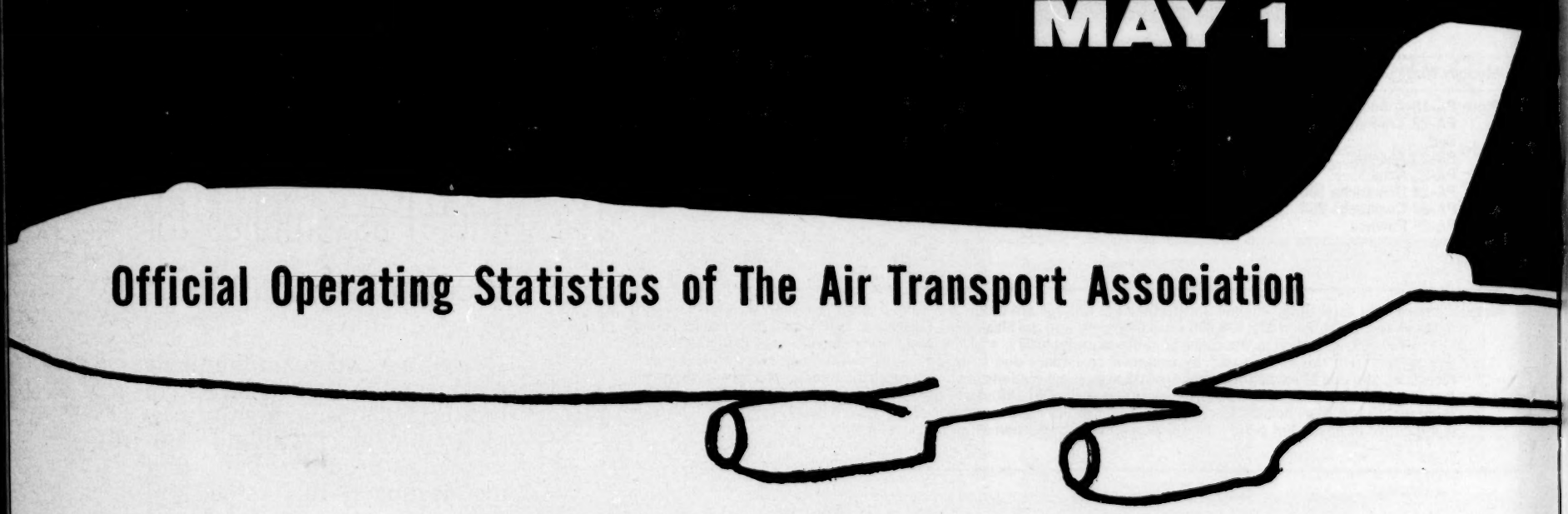
MAY 1



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Israel Delivers First Executive Conversion

First executive transport modification by Israeli Aircraft Industries, a Convair 240, has been delivered to Allied Stores, marking the firm's entry into the business aircraft field.

The Tel Aviv service company converted the former Ethiopian Air Lines' transport to a 23-passenger configuration to replace a DC-3 formerly operated by Allied Stores.

Israeli Aircraft plans to seek additional executive aircraft service and conversion business using as its selling point its low labor cost—it bills labor charges at $3 per hour. Indications are that it can deliver additional Convair 240 conversions, minus some customer options on radio and navigation equipment, in the United States for $300,000, with duty applicable to labor costs only.

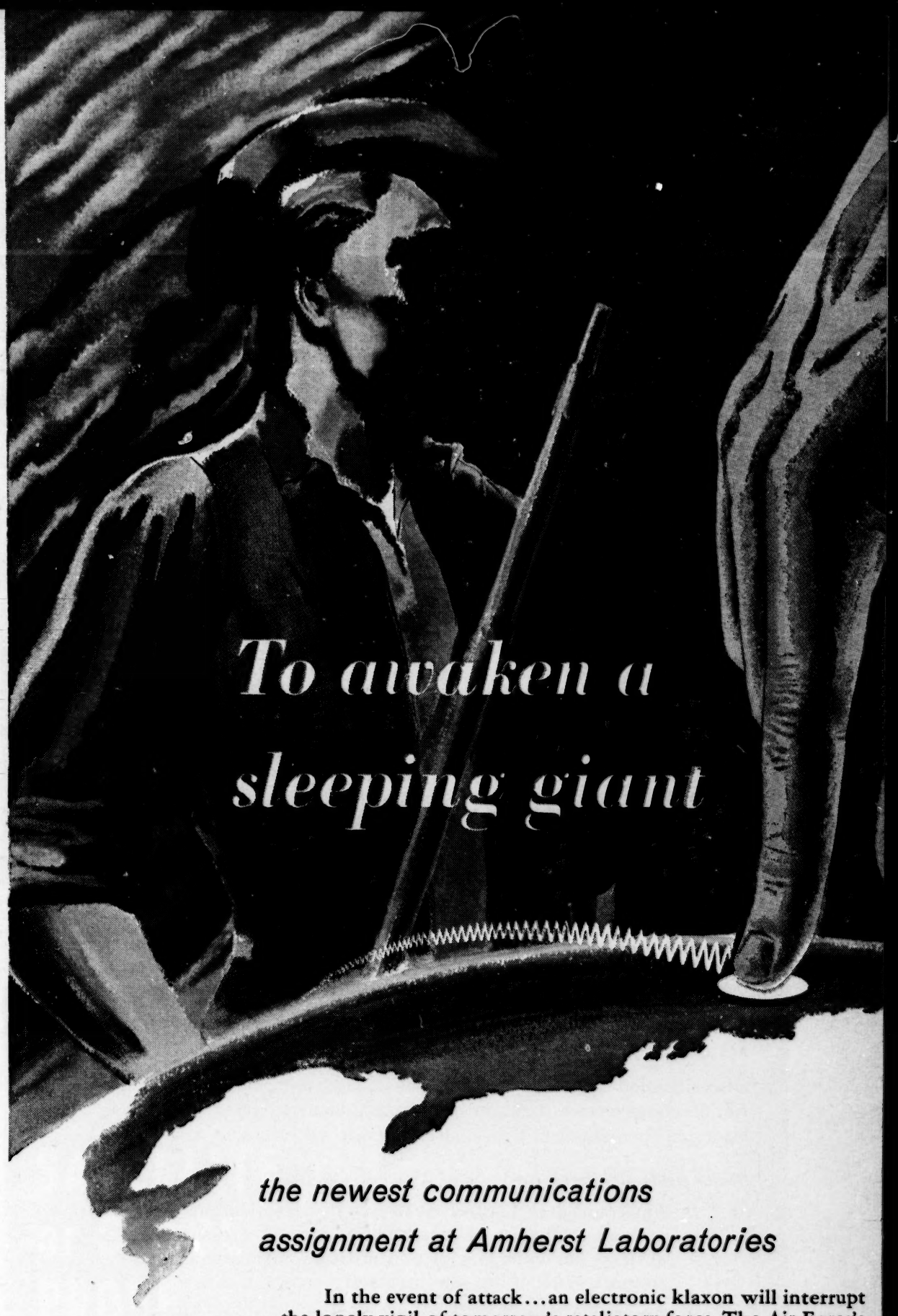
As an indication of its interest in executive aircraft, it has initiated development of a seven-passenger twin-jet transport, powered by GE's J85's (AW Mar. 6, p. 87 and Apr. 10, p. 108).

Allied's Convair is a straightforward conversion utilizing basic airframe and engines, propellers, tankage, with Israeli Aircraft performing a semi-major overhaul comprising items covered in a 4,000-hr. check and complying with all service bulletins and airworthiness directives to bring the airplane up-to-date technically with Federal Aviation Agency requirements.

Major work was in rebuilding the interior. An Israeli architect was brought in as a consultant to handle detail design of the new cabin layout and develop plans for IAI's carpentry shops. All furniture, seats, beds and lounge were made in Tel Aviv, except for two Burns Aero chairs.

Cockpit equipment includes a Sperry A-12 autopilot with approach coupler, Collins 51-R-3 omni, with two omni bearing indicators; Collins 51-V-2 glide path; Aircraft Radio Corp. ARC-210 transceiver and ARC transmitter. Plane has RCA AVQ-50 weather radar.

Israeli Aircraft Industries was formed in April 1953 and was initially known as Bedek. Operation is wholly Israeli government-owned, but is set up as a private commercial enterprise, with no civil service connections. Program is aimed at supplying a wholly self-sufficient maintenance center in the country. An FAA-approved repair facility, it also does major and minor airframe, engine and accessory overhauls. Contract maintenance is handled here for TWA, Air France, KLM, BEA, Alitalia, Swissair and Olympic Airlines. On engine overhauls it handles everything from the Continental C-90 up through the Wright R3350 piston powerplants and seven types of turbines.



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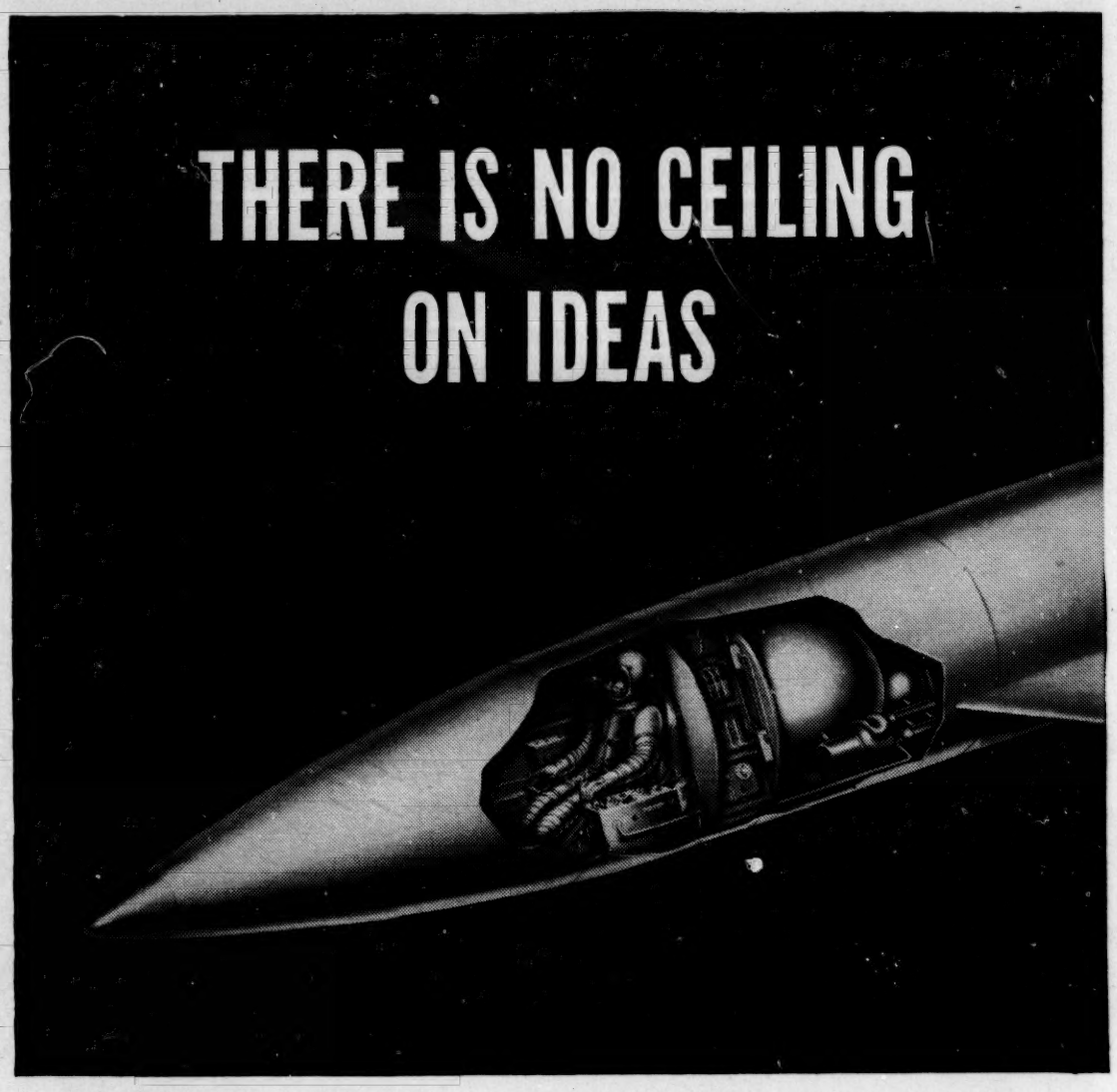

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WHO'S WHERE

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Changes

George G. Brown, Jr., manager, Vehicle Systems Programming, North American Aviation's Space and Information Systems Division, Downey, Calif.

Thomas D. Kegelman, chief-television and infrared group, United Aircraft Corp.'s Norden Division, Norwalk, Conn.

Murray Spector, Diode Plant manager, MicroSemiconductor Corp., Culver City.

John D. Gum, director of engineering, Photo-Optical Division of Consolidated Systems Corp., Monrovia, Calif.

George R. Dunbar, manager-aviation industry sales, Westinghouse Electric Corp., Pittsburgh, Pa.

William J. Henderson, general sales manager, FXR, Inc., Woodside, N. Y.

Daniel R. O'Meara, sales manager-military products, J. A. Maurer, Inc., Long Island City, N. Y.

William E. Bradley, manager of the newly formed Aero-Space Computer Section of Philco Corp.'s Computer Division, Willow Grove, Pa.

Thomas C. Weston, Jr., marketing manager, Hughes Aircraft Co.'s Communications Division, Los Angeles, Calif.

Edward R. Williams, director of engineering, Chromalloy Corp.'s Propellex Chemical Division, Edwardsville, Ill.

Stephen W. Leibholz, project engineer in charge of Air Traffic Control Data Processing Centrals Program, Auerbach Electronics Corp., Philadelphia, Pa.

John Cammarata, manager of product reliability, Arma Division of American Bosch Arma Corp., Garden City, N. Y.

A. V. Gangnes, general manager, Interstate Electronics Corp., Anaheim, Calif.; **Dr. J. F. Jenkins, Jr.,** director-engineering.

H. Herbert Jackson, manager-Nimbus weather satellite control system, General Electric Co.'s Missile and Space Vehicle Department, Philadelphia, Pa.

Reece V. Hensley, director of engineering, Systems Engineering Division, PneumoDynamics Corp., Washington, D. C.

William L. Greyson, manager of research and development, Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y.

Gordon J. Schranck, regional manager, Kidde Aero-Space Division, Walter Kidde & Company, Inc., with offices in Van Nuys, Calif.

Claire Bell, manager-instrument product engineering, Varian Associates, Palo Alto.

Col. Guy B. Richardson, Jr. (USAF ret.), special consultant to the president of General Precision, Inc., with offices in San Bernardino, Calif.

Robert L. Detwiler, chief engineer, Miller Research Laboratories, Baltimore.

Claude H. Smith, general manager, Minneapolis-Honeywell's Ordnance Division facility, Duarte, Calif.

Glen C. Danks, corporate contracts administrator, Telecomputing Corp., Los Angeles, Calif.

Dr. Ercole E. Motta, director of chemical sciences, Dynamic Science Corp., South Pasadena, Calif.

Stanley H. Levin sales manager, Systems Division, Giannini Controls Corp., Duarte.

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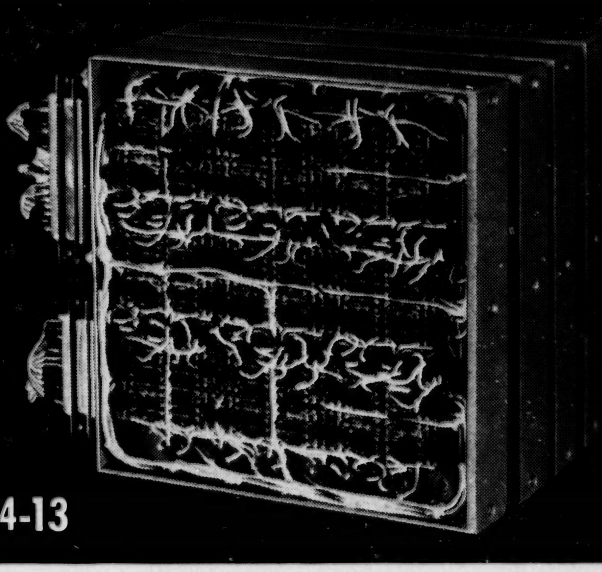

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LETTERS

Bioastronautics Effort

Your editorial on bioastronautics in the Mar. 6 issue points up one of the most serious problems this country faces in achieving manned space flight on a significant scale. Missile systems have been thought of in at least some quarters as consisting of five major subsystems: airframe, propulsion, guidance, control and warhead or payload. Each of these major subsystems has received major technical and financial support. As a matter of record, entire plants have been constructed to supply each one of them.

Today we are talking seriously about going into space. In place of a warhead, there will be a manned capsule. The amount of effort required to develop a truly effective manned payload is certainly equivalent to or greater than that required for a nuclear warhead. It is, therefore, apparent that the manned payload must be considered a major subsystem and supported in proper proportion to the effort expended on the other parts of the vehicle. Unless this is done, there is strong likelihood that the engines, airframes, etc. will be available long before the manned capsule has achieved a state of development which will make manned space flight a useful accomplishment.

There obviously exists a need for a strong national bioastronautics effort geared to provide a family of payloads for selected missions. This will require a long period of component and subsystem development. Unless foresight and action are exercised right now to institute such a program, our efforts in manned space flight will be severely restricted.

Your calling this to the attention of your readers in your editorial is a step in the right direction and I should like to congratulate you on your timeliness.

James A. Reeves
Executive Vice President
Spacelabs, Inc.
Van Nuys, Calif.

Polar Route

The article concerning U. S. foreign air policy (AW Jan. 30, p. 38) was informative and interesting, but it touched only briefly on an area that has almost suddenly gained a paramount importance in U. S. air transport negotiations with European countries: the Europe-West Coast polar route.

However, I would like to discuss an aspect of this route that is more domestic than foreign in its bases. This [illegible] around the [illegible] policy of restricting the foreign flag carriers applying for West Coast routes to serving either San Francisco or Los Angeles, but not [illegible] cities. This policy is beneficial to neither U. S. nor, of course, the foreign countries, but most of all the two cities. As a former and present resident of the San Francisco Bay area, I know that the Air France-Lufthansa case was closely watched there by [illegible] San Francisco press, and the case decision was regarded as something more [illegible] tressing.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

It is my understanding that the policy is designed to prevent the foreign airlines from capturing too large a share of the polar route traffic from the U. S. airline operating the route. This end is sound, I am sure; it is the means to the end that needs to be altered. At the moment, the either/or clause curbs the foreign carriers' traffic by limiting them to operation from one of the two cities, with another limit on number of flights. I have been able to discover no reason why both cities could not be served by the foreign airlines, as co-terminals, if their flights were further restricted—the end would be the same; the means would be changed. That is, if one airline is serving one of the two cities with two round trips weekly, it gains no seat-mile advantage if it is allowed to serve both cities with one round trip from each per week. The end result is the same as far as State Department desires are concerned, but both cities benefit.

Specifically, Air France applied for a polar route to both San Francisco and Los Angeles, was forced to choose between the two cities despite entreaties from all parties concerned, and decided on Los Angeles presumably and foolishly because of that city's population "advantage" over San Francisco. Just after Air France's decision (a little over a year ago), Lufthansa, having made the same application to serve both cities, was forced to make the same decision. Because of San Francisco's distress at Air France's forced choice (a great amount of wooing had been done by both cities to get Air France after the element of choice had been revealed, as well as the fact that TAI was also to serve whatever city Air France chose), Lufthansa was somehow encouraged to choose San Francisco.

Now, although both Los Angeles and San Francisco gained a foreign carrier, each could have gained two foreign carriers. Furthermore, doubtless there are people in San Francisco who travel by Air France for reasons of preference, and v.v. for Lufthansa and Los Angeles passengers, so they are simply being inconvenienced by having to go between the two cities. And the result is, though perhaps to a small degree, that Air France is getting San Francisco [illegible] also operating two weekly round [illegible] and v.v. for Luft- [illegible] not wanted [illegible] As another example [illegible] take the [illegible] Francisco to Los [illegible] polar flight, [illegible] well serve San Francisco, [illegible] in Los Angeles [illegible] [illegible] ageles [illegible] to its San Francisco service; it is [illegible] that British concessions may have played an important part in the award. But the point is that the State Department is not keeping the foreign airlines from carrying both Los Angeles and San Francisco traffic by limiting them to serving only one of these cities.

Finally, I would like to direct this plan not so much to those cases which are decided and closed, but to those which are to come, and in which, unlike the Air France-Lufthansa case, San Francisco seems unrightfully to stand no chance: Air-India, Alitalia, KLM; and, it will surely follow, El Al, Sabena, Swissair, perhaps Iberia, and why not, some day, Olympic and South African? Let's look ahead. It is probable that in most of these cases and the course of their negotiation the either/or clause will occur, and where it does, as an admitted San Francisco booster, I must state frankly that there is no reason why the airline involved should be caused to choose Los Angeles because of unnecessary State Department policy and meaningless population figures when both cities can be served with no increase in traffic for that airline.

If the either/or clause does not occur, or if one of the airlines to come would rather serve one of the two cities with more flights, then this is another matter. But where rights to both cities are requested then, again, I see no reason why Air-India, for example, couldn't be granted traffic rights to both cities with, say, two round trips from each per week, instead of rights to only Los Angeles with four round trips per week. As suggested in your article, there may be changes in the U. S. foreign air policy when the Kennedy Administration arrives at this problem; it is to be hoped that this disgruntling aspect of the West Coast polar route cases will be beneficially affected by such changes.

Concerning an entirely different matter, I would like to serve up some praise to your comprehensive articles on the smaller foreign air carriers—Ethiopian, et al—that have appeared from time to time. Keep 'em coming—there are plenty of foreign air carriers to be written about.

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Inboard Spoilers

Although it is not my intention to pounce on what might be a slip of the pen, I'd like to offer a clarification of a paragraph found in an article in the Mar. 20 issue of Aviation Week (pp. 67-75). Mr. Reed mentions that when the inboard spoilers are cut out and the speed brake handle actuated, the outboard spoilers will be deployed. This is accurate, but this method of controlling runaway trim, jammed stabilizer, etc., will result in a pitch-up tendency of the aircraft; not pitch down as Mr. Reed suggests. This must be true because lift is disrupted aft of the center of gravity; lift forward of the CG remains boosting the aircraft upward. This is, of course, a minor correction to an otherwise fine article.

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